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BULLETIN No. 134. DECEMBER, 1906.

INSECT NOTES FOR 1906.

This bulletin contains notes upon the brown-tail moth; Aroostook potato insects; alder blight and attendant insects; the larch case bearer; and brief notes upon the other chief insects of the year.

Requests for bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION,
Orono, Maine.

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INSECT NOTES FOR 1906.

Edith M. Patch.

Brown-tail Moth and Gypsy Moth.

Since 1903 the brown-tail moth has become established throughout the Southern and most of the coast counties of Maine. In December, 1906, egg clusters of the gypsy moth were found in Kittery and Elliot. The caterpillars of the brown-tail moth are capable of ruining orchard, shade, and many woodland trees. They are also a dreaded nuisance because their hairs break off and on coming in contact with the human skin, cause extreme irritation and often illness. The caterpillars of the gypsy moth attack nearly every kind of vegetation and their work is especially fatal to pine and other evergreens since these trees always die after being once defoliated.

Brown-tail Moth.

So serious a pest should be known by every one in the State, because although extermination of this insect may not be possible, much practical and effectual work can be done in holding it in check and reducing its numbers to such an extent that damage to orchard and shade trees may be very slight.

For the past two years the State Department of Agriculture, the State Pomological Society, the Maine Agricultural Experiment Station, the town and city officials, and the citizens of the infested localities have worked in unison against the brown-tail moth. As a result this insect has not yet done very serious damage in this State, and the cases of poisoning have been very few. This is cause both for congratulation and encouragement for it shows that even if the brown-tail moth cannot be exterminated, its ravages may be in a large measure controlled. But the same distressing conditions threaten the State this coming year, and over a much larger district, and to be met successfully these conditions must be met as vigorously and as earnestly as they have been previously.

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A simple warning to any one who may not be alive to the importance of fighting this insect is given in this bulletin by the significant photograph kindly supplied by Mr. A. H. Kirkland, State Superintendent for Suppressing the Gypsy and Brown-tail Moths in Massachusetts. The photograph, Fig. 16, shows apple trees stripped by caterpillars of the brown-tail moth, June 9, 1905, Winchester, Mass.

DESCRIPTION AND HABITS.

The moths. The moths, expanding from one and one-fourth to one and three-fourths inches, are white except for the abdomen, which is tinged with brown and tipped with a tuft of brown hairs. This tuft is small and dark in the male, but the large golden-brown tuft in the female is conspicuous enough to be the most striking characteristic of the moth, and has won for this insect its descriptive name of "brown-tail." These moths are on the wing in July, and unlike some closely related pests, the brown-tail females as well as the males are strong fliers. They are active at night, and as lights have an attraction for them, they sometimes fly a long way toward a lighted district.

The eggs. The female usually selects a leaf near the tip of the branch on which to deposit from 150 to 300 eggs. Some of the brown hairs from the abdominal tuft adhere to the egg-mass and give it the appearance of a brown felt lump.

The caterpillars in the fall. By the middle of August most of the eggs are hatched and the young caterpillars spin a slight web over the leaf near the egg cluster. From this protection they advance side by side, sometimes 200 tiny caterpillars feeding in an unbroken line, though they huddle together beneath the web when disturbed in any way. When they have eaten all but the skeleton of the first leaf, they draw another into the web and repeat the process at intervals during the late summer. They feed slowly, however, and spend so much time spinning their web that they do comparatively little damage to the trees in the fall, and they are still very small, (about one-fourth of an inch in length,) when cold weather comes on.

The Winter Nests. In the fall the young caterpillars weave additional layers of silk about their retreat, fastening it securely to the branch by the web, and pass the winter thus in colonies of 150 to 300. This is a very unusual yet most commendable habit in a caterpillar pest, for they can be killed, hundreds at a time, simply by burning the nests in which the colonies hibernate. The nests, composed of leaves bound firmly together by silken web, are varied in shape, those upon oak trees for instance being differently formed from those upon wild cherry, in accordance with the difference in the size and pliability of the leaves. They vary too, more or less, upon the same tree, in the number of attachments to the twig and somewhat in size. However, this variety in size and shape serves as a distinctive mark, as it distinguishes nests of the brown tail moth from the uniform and regular shaped cocoons of other moths found often upon orchard trees in winter. In spite of the superficial variety, the essential characteristics of the brown-tail moth nests are soon learned, and even anyone unfamiliar with the nest can make himself perfectly certain if he will cut carefully into the nest. *If the structure contains one or more silken cells filled with tiny living caterpillars it is the winter nest of the brown-tail moth.* Two types of the winter nests are shown in Figs. 17 and 18.

The caterpillars in the spring. Early in the spring the young caterpillars emerge from their winter nests and feed upon the opening leaf buds. Until about the middle of June they feed greedily upon the leaves, completely stripping the trees where they are numerous. Orchard trees are especially susceptible, but oak, elm, and many other shade and forest trees are often ruinously attacked. When full grown the caterpillars are about one and one-half inches long. They are dark brown with a sprinkling of orange. Long, fine reddish-brown hairs cover the body, and a row of conspicuous white hairs runs along each side. Like the caterpillars of the tussock and gypsy moths, they bear bright red tubercles on the top of the sixth and seventh abdominal segments.

Poisonous qualities of the caterpillars. Were the caterpillars to be feared only for their ravages upon orchard and other trees, the situation would be alarming enough, but not less serious is the physical discomfort experienced by people living in infested districts. When the minutely barbed hairs of the caterpillar come in contact with the skin they cause an eruption similar to and in many cases worse than ivy poisoning. These hairs are brittle and where the caterpillars are numerous few people are likely to escape, as the caterpillars drop from the branches and creep about, even entering houses. Direct contact with the insects themselves is not necessary however, for when the caterpillars shed their skins the molts are blown about, widely scattering the barbed hairs. Thus in infested districts it is no uncommon occurrence for whole families to suffer from the rash caused by the hairs which settle upon clothes hung out to dry. Children gathering cherries are badly "poisoned," and people have been obliged to leave their homes for uninfested places in order to recover from attacks of the "caterpillar rash," which sometimes results in serious illness.

The cocoon. The caterpillars are usually full grown in June. They then spin loose cocoons, attached commonly to leaves, though sometimes other shelter is sought. Within these they transform to brown pupæ about three-fourths of an inch long. From the first to the twentieth of July the moths with pure white wings and brown-tipped abdomens emerge from these cocoons to deposit eggs for the next generation of caterpillars.

REMEDIAL MEASURES.

Natural Enemies. In the course of time, the natural enemies may become established also and take their share in the work. Doctor Howard, Chief of the Bureau of Entomology, and Mr. A. H. Kirkland, Massachusetts Superintendent for Suppressing the Gypsy and Brown-tail moths, are uniting their efforts in introducing parasites of these moths from European countries. Results from such work are necessarily slow and though the parasites may in time become a most effective means of lessening the numbers of these introduced pests, as parasites already do with many native moths, for the present season at least they cannot be expected to serve for a substitute for other remedial measures.

Cutting and burning the winter nests is the most important of the remedies because it is the easiest, cheapest, and, if thoroughly done, a sufficient protection against the ravages of this pest. The webs and leaves that compose the nest are woven tightly to the tips of the branches and hang there like dead leaves all winter. With so many months for inspection there is no excuse for harboring the hibernating caterpillars on shade or orchard trees. After they are cut from the branches, the nests should be burned, as this is the simplest way of destroying the colony within.

Destruction of breeding places. Much can be done in infested districts by clearing out wild cherry tangles and other growths which serve as a breeding place for these moths.

Spraying. The caterpillars are readily killed by arsenical sprays. The remedy is most effective when applied as soon as the leaves develop in the spring. Of course where the winter nests have been destroyed there will be no need of this remedy and it is much easier to kill about 200 caterpillars enclosed in a nest than to wait until they are scattered over the tree.

LEGISLATION AGAINST THE BROWN-TAIL AND GYPSY MOTHS.

Legislation in Maine. In Maine the alarming invasion of the brown-tail moth during 1903 and 1904 emphasized the need of legislation against the ravages of dangerous insects and diseases, and in February, 1905, an act was passed to provide for the inspection of nurseries and incoming nursery stock, and placed with the Commissioner of Agriculture the duty of investigating any locality where the presence of dangerous insects or plant diseases may be suspected.

National Legislation. Appreciating the necessity of combating the brown tail and gypsy moths which threaten not alone the New England States, but the vegetation of the whole country, the last United States Congress passed an emergency appropriation of $82,500 to be used in preventing the further spread of these insects as far as possible.

AROOSTOOK POTATO INSECTS.

Wherever native vegetation is destroyed over a large area and a cultivated crop substituted, the equilibrium of insect conditions is upset, and a readjustment ensues If the plant-feeding insects of the locality are able to adapt themselves to a diet of the cultivated crop, the readjustment is of economic interest.

The potato fields of Northern Maine present an opportunity for observation along this line. Approximately 6,000 acres have been opened to the potato crop in Aroostook County during the past 16 years. What has become of the insects originally feeding upon other vegetation over these 6,000 acres is chiefly a matter of fruitless speculation. In general they have died, changed their location, or accepted the potato as an article of diet.

The inevitable Colorado potato beetle is taken philosophically here as elsewhere as a part of potato culture, and certain fields kept clear of it by adequate spraying and, especially late in the season, certain fields given over to its ravages with apparent indifference.

Tomato Flea Beetle. Probably more serious injury to the potato vines is inflicted by the common tomato flea beetle, *Epitrix cucumeris,* than is generally credited to this insect by potato raisers, as it is found upon the leaves during the whole season, often in enormous numbers, and the punctured and riddled leaves cannot of course do full duty in such a condition.

Smartweed Flea Beetle. In addition to these two foregoing omnipresent pests, the Aroostook fields possess some more distinctive features. About the middle of September the smartweed flea beetles, *Systena hudsonias* were even more numerous than the smaller species. Both at Caribou and Houlton they were especially abundant and a potato leaf untouched by them could scarcely be found.

Cosmopepla carnifex. A pretty black and red bug, *Cosmopepla carnifex,* content before the advent of the potato to feed upon tender poplar shoots, and mint and buttercup stems, has shown no hesitation in accepting the new feeding grounds. By way of illustration it may be cited that on Sept. 12 at Caribou 11 of these bugs were found with their beaks deep in a single potato stalk. The bugs looked healthier than the stalk.

Pentatoma juniperina Linne. This large green bug, not uncommon in the State upon evening primrose, was found upon the potato, at Caribou July 11, where it was accused of wilting the stalk.

Tarnished Plant Bug. The tarnished plant-bug, *Lygus pratensis,* of evil reputation everywhere, is guilty of various annoyances in Maine. In some parts of the State, pear trees suffer through serious attack of the swelling leaf and flower buds in the spring. In a second the aster buds are "buttoned" by this bug so that "no perfect flowers can be obtained for sale." From a third, complaints accompanied by tarnished plant-bugs, state that all of many dahlia blossoms are deformed,—opening feebly only on one side. At Portland they were thick upon celery. The adults of this species can be startled from goldenrod blossoms almost anywhere in the State. It is not surprising to find such an adaptable insect taking without question the food offered it over thousands of acres of potato vines. About the middle of September different fields over a stretch of 7 miles near Houlton were visited. All these fields were infested by the tarnished plant-bugs, and in one field visited early in the morning before the insects had warmed up enough to be much on the wing 40 or 50 plant-bugs to a single plant was not an unsual number. This fact seems an alarming one, for though the injury so late in the season may not be of great importance, the hibernating adults, if they attack the early tender shoots in the spring as is their habit on other plants, will cause much deformed and stunted growth another season. The tarnished plant-bug is not an easy foe to meet. Paris Green or other stomach poisons are useless against an insect with sucking mouth parts. Kerosene emulsion or other contact remedies are not practical for a pest which is so easily startled to flight. At the slightest disturbance the plant-bug is on the wing and in condition to return to the plants when the danger is over. From certain garden plants the plant-bug can readily be shaken onto a cloth or into a pan containing kerosene, early in the morning or on cold days when they are too sluggish to be easily alarmed. Such a means would, of course, be impractical in a potato field. There remains apparently but one vulnerable point, based upon the fact that the tarnished plant-bug hibernates in the adult condition among weeds or other rubbish. The custom of potato raisers of raking up and burning the old vines in the fall in order to have fields clear for fall plowing is therefore one of the most effectual ways of destroying the shelter of these bugs. If, in addition to clearing away the old vines, the weeds and rubbish along the edges of the potato fields should be burned on a cold day, great numbers of the tarnished plant-bugs would be destroyed with comparatively little cost and time. If the plant-bug continues to appear upon the potato vines, this means of combating it should be resorted to regularly each fall.

Nectarophora solanifolii. In a land flowing with honey dew as has been the whole State of Maine for several years past, even the potato cannot hope to escape aphid attacks. A large green species, *Nectarophora solanifolii* Ashm. has for 3 seasons attacked the potato vines in the vicinity of Houlton and elsewhere to an injurious extent. The colonies cluster thick on stem and leaf, thousands to a plant, frequently wilting the stems and drying the leaves. The worst of the attack comes between the middle of August and the middle of September in time to weaken the plant and thus effect the growth of the tubers. The true sexes of this species do not appear upon the potato. It is not yet known what plant serves for the alternate host.

Aphis sp. This present season in some parts of Aroostook, conspicuously at Caribou and vicinity, a second species of plant louse, an undetermined and probably a new species belonging to the genus *Aphis,* has heavily infested certain fields. They were beginning to appear upon the vines about the middle of July and they had not all taken flight by the middle of September. At the later date colonies of pupæ could be found here and there at Caribou, clustered thick enough on stalk tip and new growth to hide the stalk. The bodies of these pupæ shaded from pink to salmon and from green to brown. They seem invariably to feed head down.

The presence of plant lice to such an extent upon potato vines raises several perplexing problems. If a fairly uniform attack could be reckoned on each year, the cost, benefit and practibility of emulsion sprays on the infested fields would be well worth testing. Plant louse attacks, however, are likely to be irratic, influenced by climatic conditions and by decrease and increase of parasites and predaceous insects. As yet it seems to be an open question as to whether it is most practical to attempt to combat the aphids in the potato field by artificial means, or leave them to fluctuate according to natural influences. At any rate their presence is to be regretted. Even a light attack which would not preceptibly weaken the plant, probably renders it more susceptible to fungus diseases than it would normally be. For the past 3 years the aphid attacks on potato have been widespread. Dr. James Fletcher, Central Experimental Farms, Canada, writes from Ottawa, September, 1906, "The aphis has been extremely abundant on our potatoes all through this part of Canada this year." It also troubled Canadian fields in 1904.

ALDER BLIGHT AND ATTENDANT INSECTS.

A conspicuous illustration of the natural fluctuations of insect conditions is given by *Pemphigus tesselata* in the vicinity of Orono. This species, a large dark bodied plant louse infesting the trunks and branches of alder (*Alnus incana*), is often mistaken for fungus on account of the snow-white flocculent matter with which it is covered. For several seasons the alder clumps here as in many other parts of the State have been white stemmed with this woolly plant louse, and early in September the air has been alive with the winged forms.

Syrphus maggots. The chief enemy which had for two seasons confronted the "alder blight" was a syrphus fly, which could be seen hovering near the colonies for the purpose of depositing eggs. The maggots hatched from these eggs fed greedily upon the large soft bodied plant lice, but the enormous numbers of the plant lice did not seem to be materially lessened. The winged forms were plentiful last fall, 1905. This spring the colonies were common but not so numerous as for several seasons past. The syrphus maggots work industriously and often white "wool" upon the alder stems was found to cover more maggots than plant lice. It seems likely that the syrphus flies could clear the vicinity of "alder blight." Late in the summer, however, it was discovered that the syrphus flies no longer had the "alder blight" to themselves. A rival appeared in the form of the Harvester butterfly.

The Harvester, Feniseca tarquinius. (Fig. 19). During September caterpillars of the Harvester could be taken in almost any colony of "alder blight" in the neighborhood. Like the syrphus maggots, these caterpillars burrow beneath the woolly secretions of the plant lice and are covered from sight. The full grown caterpillar is slightly more than one-half inch in length and slug like in shape. The body is drab colored and the head a shiny brown. The 12 segments of the body are deeply creased and scalloped along the lateral margin. There is a mid-dorsal line of black dots with an orange spot at each side. Each orange spot is lined laterally with black. The body is well covered with black bristly spines to which flocculent masses from the alder blight becomes attached. The curious chrysalis (Fig. 20) of this insect is a half uncanny, wholly fascinating little object with the dorsal aspect possessing a remarkable resemblance to a monkey's face. The adult butterfly (Fig. 21) expands about one and one-fourth inches. The colors of the upper surface of the wings are black and tawny. The black spots are subject to much variation in form and size.

So industriously did the Syrphus maggots and the Harvester caterpillars feed upon "alder blight" that by the end of September hardly a colony of this plant louse could be found in the vicinity of Orono.

Alder blight covered by ants. In connection with a series of observations which were being made this season on alder blight, an interesting bit of ant work was noticed August 30. A colony of ants had its quarters in some small decaying tree trunks fallen at the base of a clump of alder. Two of the alder stems were thickly infested with *Pemphigus tesselata* much visited by ants for the honey dew. In this case the ants had built a covered tunnel from the base of the alder stems to the distance of nearly 2 feet on one stem and more than one foot on another. This structure was composed of sawdust-like particles and enclosed small clusters of the aphids which seemed undisturbed by the proceedings. The stems were upright and one ant tunnel was erected vertically along the stem while the second was more or less winding. The ants varied their occupation of extending the tunnel with sipping upon the convenient honey dew. Specimens of these ants were identified by Mr. Theo. Pergande of the U. S. Department of Agriculture as *Lasius mixtus* Mayr.

LARCH CASE-BEARER, *Coleophora laricella* Hbn.

Throughout Washington, Hancock, and Penobscot counties at least, and probably over a larger area a very minute moth has been to work on the larch, (*Larix americana*), or hackmatack, or tamarack as it is variously called.* The insect winters in the larval stage upon the larch and attacks the tender needles when they first start in the spring. Although minute they have been present in such enormous numbers that larch trees have often been, during the past 3 seasons, eaten bare of green early in the spring. The caterpillars feed by eating a hole in the side of the needle and then devouring as much of the inner portion as it can reach. It thus has the characteristic manner of feeding common to related leaf miners. The injured needles often continue to grow but the clusters are ragged and many of the needles brown and dry. Small larches in the vicinity of Bangor and Orono which have been subjected to an attack of at least 3 seasons died this summer from no other apparent cause than the presence of great numbers of the case-bearers which kept the needles eaten off. Many large larches infested by this insect look yellowish and unhealthy.

The larva. The caterpillar is a case-bearer, that is, it protects its body with an external covering or case. The larch case-bearer uses a bit of dried spill from the larch for its case and from this protection it extends its head and thoracix feet when it wishes to move about or feed. Along the ventral side the spill is split and pieced together with silk woven by the tiny caterpillar. As it grows it weaves an extension of this silk on the anterior part of the case. The full grown caterpillar is about 3 millimeters * in length. The case measures 4 millimeters or 5 millimeters. The caterpillars are much more active during warm and sunny weather, and during cold days they do no feeding. When fall comes on the nearly grown caterpillars in their little spill cases attach themselves to the bark and about the bud angles and live dormant for the winter. With the first warm days of spring the caterpillars become active and feed upon the soft tender larch needles. As the caterpillars are nearly full grown this is their most vigorous feeding spell and as the larch needles are eaten when they first begin to grow, it is a particularly hard season of the year for the tree to endure such an attack. The same number of case-bearers later in the season would by no means create so much damage.

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* Although so well supplied with popular names of its own, this tree is also erroneously but very commonly called the juniper in Maine.

The full grown caterpillars do not leave their cases but attach them to the twig or commonly in the cluster of needle shaped leaves where they are not easy to find and let the cases serve for a cocoon.

The moth. - In the vicinity of Orono the adult insect emerges about June 4. They are a glistening ash gray in color. The wings are slender and the hind wings have the deep delicate fringe common to this group of moths. It expands about 9 millimeters. This moth is something the shape of the common clothes moth and a little smaller. The female deposits the eggs in among the larch needles and the young naked caterpillar eats its way into a needle and after disposing of the soft interior as food, uses the empty shell for its case.

There is fortunately but one generation a year. Observations upon these case-bearers about Orono had been made during 2 seasons when Dr. James Fletcher, Central Experimental Farm, Ottawa, published his interesting account of the appearance of the Larch case-bearer, *Coleophora laricella* in Canada (Report 1905). Doctor Fletcher kindly compared specimens bred in Maine with the Canadian *Coleophora* and pronounced them undoubtedly the same species. Ratzeburg in his Forst-Insecten gives excellent figures in color of the larva, moth, and work of *Tinea laricinella* which if it is not the same species as *Coleophora laricella* so closely resembles it that the same figure would serve for both.

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* One inch nearly equals 25 millimeters.

There would not seem to be any practical remedy against this insect in large growths. Since it eats the inner portion of the needles and leaves the epidermis, arsenical sprays would hardly avail on the larches used for ornament. In nurseries, badly infested trees should be burned. From very small trees the majority of the cases could be removed by hand during the winter. Japanese Larches * are said to be immune from attack by this case-bearer.

MISCELLANEOUS NOTES.

Of the many insects which naturally come under observation during the season, a few are conspicuous for various reasons, as the attendance of particular parasites, the occurrence in great numbers of an insect not usually abundant, or the appearance of an insect on some plant it does not commonly attack. Such instances are often of more than passing interest and are conveniently recorded under miscellaneous notes of the year.

Yellowhead Cranberry Worm on Sweet Gale. The yellowhead cranberry worm, *Teras minuta,* was present this season over cranberry beds near Charlotte. The culture of these beds had been somewhat neglected and sweet gale, *Myrica gale* had crowded into the beds from all directions. The tips of the sweet gale were everywhere conspicuously spun together and examination showed the culprit to be the yellowhead cranberry worm which was working also in the cranberry vines. The pest was attacking the sweet gale to a much greater extent than it was the cranberry itself. This fact was so marked that it suggested, as apparently practical, a simple remedial treatment for this locality. It was recommended that all of the sweet gale, which was injuring the cranberries by its presence as a weed, should be torn out except strips of it near the edges of the beds which were to be left as a trap. The sweet gale, left as attractive bait for the yellowheads, could be treated to a heavy spray of arsenate of lead early in the spring, in time for the first brood of larvæ, thus killing in small space the majority of the pests. The beds, it should be stated, are in a dry bog and resort to flowing would mean considerable expense. The same insect was present at Charlotte upon apple trees but not to a great extent.

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* Insect Life. Vol. IV. Page 405.

The Apple Maggot and the Codling Moth. Both these insects are at work in this State to a regrettable and injurious extent. There is considerable confusion among orchard owners as to the character and names of these two pests. The term "apple maggot" is unfortunately applied indiscriminately to the larva of "Trypeta" and the codling moth, and the term "railroad worm" is not much more definite, especially if the trails extend away from the surface of the apple. The present season one man reported that nearly all his apples were "ruined by the 'railroad worm' or 'wire worm' as it is sometimes called." In view of such confusion the following brief statement may not be amiss.

"Apple maggot," "railroad worm," and "Trypeta" should all properly apply to the larva of a striped winged fly, *Rhagoletis* (*Trypeta*) *pomonella.* This larva is a *maggot,* a small but plump, white, footless object with head so ill defined that it is difficult to find at all, and the mouth parts reduced to a pair of hooks. The apple maggot works in soft discolored mushy trails anywhere in the pulp of the apple. When these trails lie immediately under the skin of pale skinned apples they show through like tiny but clearly defined tracks, and the descriptive term "railroad worm" has been given the maggot which travels along these tracks. The trails of the apple maggot never contain little round sawdust like pellets, and they do not extend into the core of the apple.

The codling moth (*Carpocapsa pomonella*) is a true moth. The fore wings are irregularly streaked with gray and brown, and have a horseshoe marking of copper color at the inner angle. The hind wings are of light yellowish brown. The moth expands about three-fourths of an inch. The larva of this moth is a tiny naked *caterpillar* with clearly defined head region and three pairs of legs upon the segments immediately behind the head. It has the ordinary biting mouth parts of other caterpillars and resembles the closely related leaf folding caterpillars (Tortricids) in its motions, wiggling violently backward when disturbed. The larva of the codling moth makes excavations in the apple, extending them usually into the core itself. These excavations always contain little, round, brown, sawdust-like, pellets which are the excretions of the larva.

The apple maggot and the larva of the codling moth are often present in the same apple. Discussions of the life history, habits and remedies of these two pests are given in other available bulletins of this Station and are therefore not repeated here.

Lace Bugs. The recently described * Tingitid, *Corythuca pergandei* Heid. was extremely numerous upon willow and alder (*Alnus incana*) between Bangor and Orono this season.

Infested Spruce Cones. Late in August the cones on the Norway spruces on the campus were observed to be dropping prematurely. Examination showed a general infestation by a Lepidopterous larva about seven-eighth of an inch in length. Some were a uniform purplish brown, others showed a greenish color on the thoracic segments with 2 tiny black spots on the first segment behind the head. These larvæ began spinning cocoons about the middle of September. The cocoons are the color and transparency of thin white tissue paper. The average length is about one-half inch and they are usually about one-fourth of an inch wide, though sometimes the cocoons are nearly as broad as long. Pupation does not take place at once but the caterpillar, readily seen through the thin cocoon, lies for days in a U shaped loop. If the cocoon is disturbed, the caterpillars break through and travel off actively and with apparent irritation. The infested cones were prematurely brown in the vicinity of the larval tunnels. The excavations were chiefly at or near the center of the cones, from one to several larvæ being present in a single cone. Through the kindness of Doctor Howard specimens were referred to Mr. Fiske (Bureau of Entomology, Washington, D. C.) who stated them to be evidently a species of Pinipestis, mature moths being necessary for full determination.

Maggots which were attacking the decaying portion of the cones infested by these caterpillars developed in abundant numbers into *Drosophila amœna* Loew, kindly determined by Mr. D. W. Coquillett. This small red-eyed fly with yellow thorax and dark abdomen, and wings crossed with 2 dusky bands, is not uncommon about decaying fruit.

Harvest fly, *Tibicen rimosa.* A very pretty harvest fly, or cicada, belonging to the same genus as the periodical cicada was common in the vicinity of Orono from the middle to the latter part of July. (A photoghaph of this species is given as Fig.

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* Proceedings of the Entomological Society of Washington, Vol. VIII Nos. 1-2.

22.) The head and thorax have clearly defined marks of deep orange yellow, along the posterior margin of each abdominal segment is a narrow but distinct line of the same color, and the wings near the body are clouded also with orange. The expanse of wings averaged about 2 and one-half inches. The species was kindly determined by Mr. Heidemann as *Tibicen rimosa* Say, var: *noveboracensis* Fitch.

Diamond-back Moth, Plutella cruciferarum, as a Greenhouse Pest. Early in April a complaint came from a greenhouse in Ellsworth of a small green caterpillar which destroyed ten weeks stocks, working on leaves and flowers. Specimens were received with the communication and were bred to the adult stage, part of them proving to be the light form and part the dark form of the Diamond-back. On May 24, a new lot of these larvæ were received from the same source again at work upon the stocks. This species, described with reference to materials bred on stocks in greenhouse, is as follows:

The caterpillars when full grown are three-eighths of an inch in length. The color is a light green with the head concolorous or sometimes shading to yellowish. The median dorsal line is a more vivid green. To the naked eye they appear smooth, but a low power glass reveals stiff dark hairs rising from lighter spots arranged in a regular manner upon the segments, These hairs are most numerous upon the last thoracic segment. The last pair of abdominal pro-legs are extended back horizontally giving the body a forked appearance. The pupal stage is passed within a very delicate white, gauzy cocoon through which the pupa is readily seen. Some of the specimens reared passed but 6 days in the pupal stage.

The perfect insect is a moth expanding about five-eighths of an inch. The fore wing is ash colored with minute dark spots upon it. A yellowish stripe outlined with a dark line extends along the hinder margin in such a manner that when the wings are closed, 3 light colored diamond shaped markings are formed. Both pairs of wings are a uniform gray on the under side. The antennæ are marked with alternate rings of white and dark.

The Diamond-back is an imported moth and it occurs frequently upon cabbage and cauliflower in the garden. Doctor Fletcher reports * the Diamond-back to be an incessant and most troublesome pest upon garden stocks and wall-flowers from about July till the frosts in November. The remedy most frequently recommended is kerosene emulsion.

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* Can. Exp. Farms 1890, p. 165.

The greenhouse infestation at Ellsworth started on stocks that had been transplanted from outside and the larvæ were probably taken in with them, successive generations developing within doors. Hand picking proved to be a perfectly effectual remedy though a tedious task.

Six Troublesome Orchard Insects. The yellow-necked caterpillar, *Datana ministra,* and the red-humped caterpillar, *Œdemasia concinna,* have created much alarm in Maine this year. Entire orchards have been despoiled by these pests. Young trees have suffered the worst injury not because the caterpillars show a preference for them, but because one brood is sufficient to strip a small tree, and the same number of leaves from a large tree does not mean so serious a loss. *The bud moth, Tmetocera ocellana,* is at present doing much damage in Maine orchards. Two species of tussock moths, *Notolophus leucostigma* and *antiqua* have been abundant in most parts of the State as has the orchard tent caterpillar.

Limneria guignardi Prov. The red-humped caterpillars have been in the southern counties abundantly attended by an ichneumon parasite, *Limneria guignardi* Prov.* These parasites attack the young caterpillars in the early stages, at which time the caterpillar is just the right size to serve for food for a single parasite. The parasite grub when full grown forms its cocoon within the empty skin of the caterpillar which fits tight over the cocoon. The caterpillar head being still attached, the object is a curious one. When about to emerge the adult parasite gnaws a hole at one end of the cocoon and takes wing. This hole is sometimes near the head and sometimes near the caudal end of the caterpillar skin. See Fig. 23.

Yellow-edge Butterfly. From York to Aroostook counties the spiny caterpillars of the yellow-edge butterfly, *Euvanessa antiopa,* have been common on elm and willow. This species has been almost constantly mistaken for gypsy caterpillars, and has been the cause of numerous false alarms. A brood is occasionally found upon apple trees, but it does not seem likely to become an orchard pest, its preference is so evidently for willow and elm. A Tachina parasite is active against these caterpillars in Maine.

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* Determined by comparison with Canadian material through the kindness of Doctor Fletcher.

Garden Fleas. In contrast with the past two seasons no observations of the garden flea, *Smynthurus albamaculata,* Harvey were made. During the early spring, at the time these minute insects have previously been most conspicuous, continuous rains prevented field observations on such insects as these. The account of injury due tc this species given in Bulletin No. 123 of this Station, page 220, was the occasion of several requests from specialists in this group for reference to the original description. Professor Harvey's description together with drawings by Mr. J. H. Emerton were published in the Report of this Station for 1896, pages 124-126.

Mosquitoes. There is no adequate record of Maine mosquitoes although in many parts of the State certain species are excessively troublesome. A few collections were made this season and sent to the Bureau of Entomology, Washington, D. C., where several specialists are at work on this family. Doctor Dyar kindly determined them as follows:

Anopheles punctipennis Say. Orono, July 27 and October 1, about light in house.

Anopheles quadrimaculatus Say. Orono, September 20, in house.

Aëdes fuscus O. S. Orono, July 27.

Aëdes canadensis Theob. Trenton, August 10; Caribou, August 17.

Aëdes sylvestris Theob. Trenton, August 10.

Aëdes sollicitans Walk. Trenton, August 10.

Aëdes abfitchii Felt, *fitchii* Felt, or *subcantans* Felt. (Adults alike—need larvæ to separate). Orono, August 3; Trenton.

All of the species of *Aëdes* except *fuscus* given in the foregoing list were until recently commonly referred to the genus *Culex.*

Insects for Identification. A few, only, of the large number of insects received for identification this season are recorded in the following pages.

Such common, widespread, and constantly occurring forms as the cecropia moth and oyster-shell scale have been omitted. Such information as the increasing parasitism of the red-humped caterpillar has been summarized in a single statement elsewhere in the bulletin rather than listed as 70 or 80 separate items.

INSECTS RECEIVED FOR IDENTIFICATION.

Name.	Date.	Host.	Locality.	Remarks.
Nessus sphinx, *Amphion nessus*	June 14		Orono	Adult.
Galium sphinx, *Deilaphila chamænerii.*	June 14		Orono	Adult.
Wild cherry sphinx, *Sphinx drupiferarum*	June 16		Orono	Adult common.
Thysbe Clear-wing, *Hemaris thysbe*	June 18		Surry	Moth on lilac blossom.
Azalea sphinx, *Ampelophaga choerilus*	June 29		Bar Harbor	Male
Small eyed sphinx, *Paonias myops*	July 14		Orono	Adult.
Big poplar sphinx, *Marumba modesta*	July 13		Orono	Adult.
Pen marked sphinx, *Sphinx chersis*	July 14		Bangor	Female.
Apple sphinx, *Sphinx gordius*	July 17		New Vineyard	Female.
Laurel sphinx, *Sphinx kalmiæ*	July 27		Orono	Adult.
Morning sphinx, *Deilephila lineata*	Aug. 1		Eden	Larvæ full grown.
Twin spotted sphinx, *Smerinthus geminatus*	Aug. 1		Waterford	Adult.
Woodbine sphinx, *Pholus achemon*	Aug. 14	Woodbine	North Berwick	Larvæ "appear every year".
Four horned sphinx, *Ceratomia quadricornis*	Sept. 1		Houlton	Larva.
Walnut Datana, *Datana angusii*	Aug. 22	Walnut	North Berwick	Larvæ numerous, specimen parasited.
Walnut Datana, *Datana angusii*	Aug. 27	Walnut	North Berwick	Trees entirely stripped of leaves.
Unicorn prominent, *Schizura unicornis*	Aug. 22	Apple	Green	
Unicorn prominent, *Schizura unicornis*	Aug. 28	Apple	Jonesboro	
Unicorn prominent, *Schizura unicornis*	Sept. 1	Apple	Deer Isle	
Unicorn prominent, *Schizura unicornis*	Aug. 14	Apple	North Jay	
Hag moth, *Phobetron pithecium*	Aug. 2		North Buckfield	Cocoon.
Yellowhead cranberry worm, *Teras minuta*	Aug. 29	Cranberry	Charlotte	Larvæ numerous.
Lesser apple leaf folder, *Teras minuta*	June 21	Apple	Foxcroft	Larvæ numerous in orchard.
Fork-tailed caterpillar, *Cerura borealis*	Sept. 7		Weeks Mills	Larva.
Apple Bucculatrix, *Bucculatrix pomifoliella*	Sept. 10	Apple	East Corinth	Ribbed cocoons numerous.
Apple Bucculatrix, *Bucculatrix pomifoliella*	Oct. 15	Apple	Manchester	Ribbed cocoons.
Hickory tiger moth, *Halisidota caryæ*	Sept. 17	Apple	Drew	
Lappet moth, *Tolype velleda*	July 31		East Orrington	Larva full grown.
Beautiful wood nymph, *Eudryas grata*	Aug. 6		Hampden Corner	Adult.
Pearly wood nymph, *Eudryas unio*	July 23		Orono	Adult.
Tussock moth, *Notolophus leucostigma*	Aug. 7	Raspberry	Norridgewock	Much damage.
Fingered dagger moth, *Acronycta dactylina*	Aug. 18		Ellsworth	
——— *Acronycta americana*	Sept. 7	Maple	Bar Harbor	Larva.
Crompton tortoise, *Vanessa j-album*	Sept. 23		Charlotte	Adults very common.
The Relict, *Catocala relicta*	Sept. 9		Orono	Adults on birch bark.
Scalloped Owlet, *Scoliopteryx libatrix*	Feb. 16		Gardiner	Dead moth.

Diamond back moth, *Plutella cruciferarum*	April	2	Stocks	Ellsworth	Larvæ destructive in greenhouse.
Budmoth, *Tmetocera ocellana*	June	13	Apple	Turner	Larvæ.
Spruce tortrix, *Tortrix fumiferana*	June	20	White spruce	Bar Harbor	Larvæ.
Larch case bearer, *Coleophora laricella*	June	26	Larix americana	Machias	Larvæ seriously stripping trees.
Cherry tree leaf folder, *Cacœcia cerasivorana*	July	2	Wild cherry	Waterford	
Cherry tree leaf folder, *Cacœcia cerasivorana*	July	13	Wild cherry	Skowhegan	Nest and pupæ.
Oak ugly nest, *Cacœcia fervadana*	Aug.	1	Oak	Bar Harbor	Nest, larvæ and pupæ.
Stalk borer, *Papaipema nitela*	July	14	Sweet corn	Cape Elizabeth	Destroying much.
Primrose moth, *Rhodophora florida*	July	27		Orono	Moths common in closed flowers of œnothera biennis.
Twice stabbed Lady beetle, *Chilocorus bivulnerus*	Aug.	29	Plant-lice	Ellsworth	Numerous.
15-spotted Lady beetle, *Anatis 15-punctata*	June	7	Plant-lice	New Vineyard	On house plants.
Saw-tooth grain beetle, *Silvanus surinamensis*	March	15	Flour	Farmington	
White grubs, *Lachnosterna*	June	5	Grass roots	Harrison	Grubs worked two acres grass land so that it plowed like old ground.
Asparagus beetle, *Crioceris asparagi*	Sept.	17	Asparagus	Brunswick	¼ acre completely stripped by middle of August.
Beautiful maple borer, *Plaginotus speciosus*	July	18	Maple	Unity	
——— *Malachius æneus*	June	20		Orono	Identified by Dr. Chittenden.
Tortoise beetle, *Coptocycla signifera*	July	24	Convolulus sepium	Orono	Numerous.
Tortoise beetle, *Coptocycla purpurata*	Sept.	13	Convoullus sepium	Orono	Numerous.
Spindle gall, *Pomphigus ulmi-fusus*	July	13	Elm	North Berwick	Numerous.
——— *Pemphigus populimonilis*	Aug.	14	Poplar	Bar Harbor	Galls.
Pineapple gall, *Chermes abietis*	Aug.	1	Spruce	Portland	Galls numerous.
——— *Chionaspis salicis*	Sept.	15	Viburnum alnifolium	Houlton	Thickly infested.
——— *Eulecanium quercitronis*	June	23	White oak	Freedom	In great numbers.
Pear tree Psylla, *Psylla pyricola*	Sept.	1	Pear	Pittsfield	Work on pear leaves.
——— *Pentatoma juniperina*	July	11	Potato	Caribou	Feeding on the stalk, wilting it.
Four-lined leaf-bug, *Pœcilocapsus lineatus*	July	24	Geranium	North Berwick	Troublesome every year.
Tarnished plant-bug, *Lygus pratensis*	Oct.	1	Celery	Portland	Numerous.
Tarnished plant-bug, *Lygus pratensis*	Sept.	15	Potato	Houlton	Enormous numbers.
Tarnished plant-bug, *Lygus pratensis*	Sept.	23	Dahlia	Charlotte	Deformed and buttoned blossoms.
Tree hoppers, *Enchenopa binotata*	July	24	Wax work	N. Berwick	Great numbers.
Tree hoppers, *Telamona monticola*	Aug.	1	Woodbine	Bangor	
——— *Diedrocephala versuta*	Sept.	10	Birch sprouts	Orono	Great numbers.
——— *Cosmopepla carnifex*	Aug.	4	Mint	Orono	Great numbers.
——— *Cosmopepla carnifex*	Sept.	12	Potato	Caribou	Common.
——— *Cosmopepla carnifex*	Sept.	15	Poplar	Houlton	Abundant.
——— *Banasa dimidiata*	Sept.	15	Willow	Houlton	Adults exceedingly numerous.
——— *Banasa dimidiata*	Sept.	15	Mountain Ash	Houlton	Larvæ adults numerous in berry clusters.

INSECTS RECEIVED FOR IDENTIFICATION—CONCLUDED.

Name.	Date.	Host.	Locality.	Remarks.
Ichneumon, *Thalessa lunata*	Aug. 22		E. Wilton	Female.
Pear tree slugs, *Eriocampa cerasi*	Sept. 24	Cherry & Plum	Corinna	Bad attack.
Rose slugs, *Monostegia rosæ*	July 18	Rose	Hancock Pt	Ruined appearance of bushes for four years.
Blackberry seed gall, *Diastrophus cuscutæformis*	May 4	Cultivated blackberry	Gardiner	
Giant American saw fly, *Cimbex americana*	Aug. 1	Elm	S. Berwick	Larva full grown.
Solitary wasp, *Eumenes fraternus*	Aug. 14		Gardiner	"Jug nest" and wasp which emerged.
——— *Limneria guigrardi*	Aug. 29		Augusta	Parasites bred from Œdemasia concinna.
King grasshopper, *Hippiscus tuberculatus*	June 2		Hampden Cor.	Male and female adult.
Sheep bot-fly, *Œstrus ovis*	May 3	Sheep	E. Dixfield	Maggots in nasal passages apparently caused death of sheep.
Maple spot-gall, *Sciara ocellata*	July 2	Maple	Seal Harbor	
Psocids	Aug. 14	Maple and mulberry	N. Parsonfield	On bark in "large droves".
Psocids	Aug. 14	Maple	Alfred	On bark "by thousands".
Psocids	Aug. 18	Maple	Lovell	On bark in great numbers.

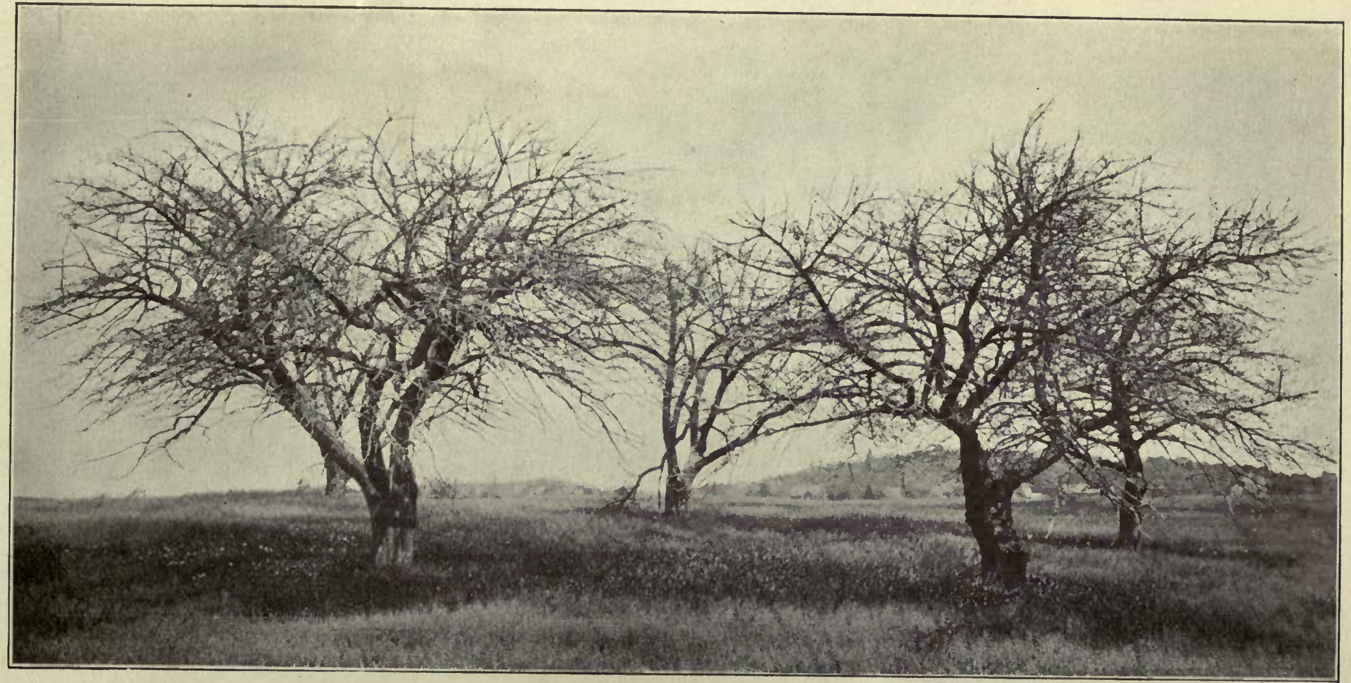


Fig 16. Apple trees stripped by brown-tail moth, Winchester, Mass., June 9, 1905.

Photograph loaned by A. H. Kirkland

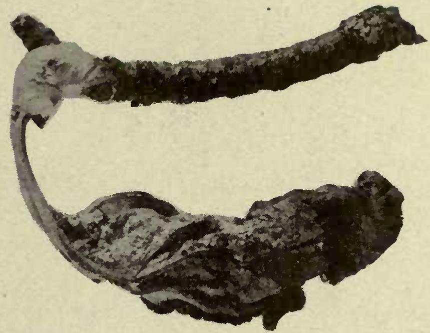


Fig. 17. Winter nest of brown-tail moth with one attachment to twig.

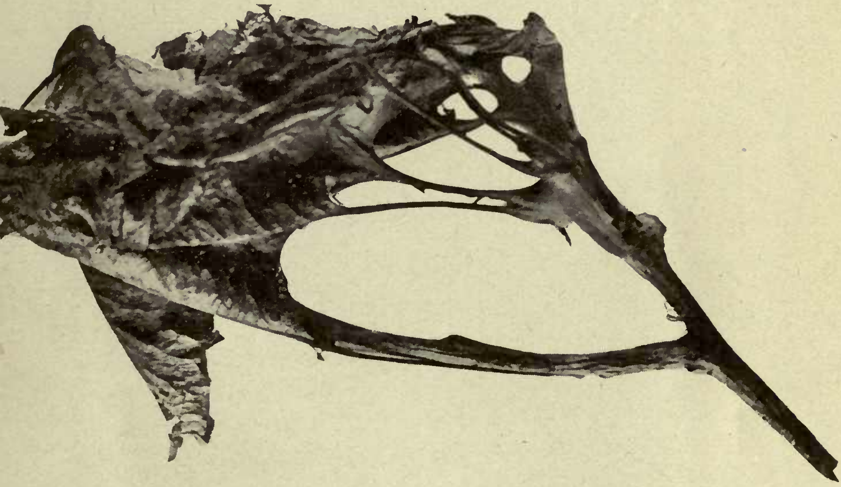


Fig. 18. Winter nest of brown-tail moth with several attachments to twig.

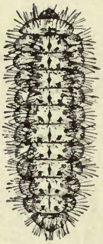


Fig. 19. The Harvester.
Larva x 2.

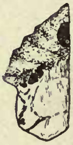


Fig. 20. The Harvester.
Chrysalis x 2.

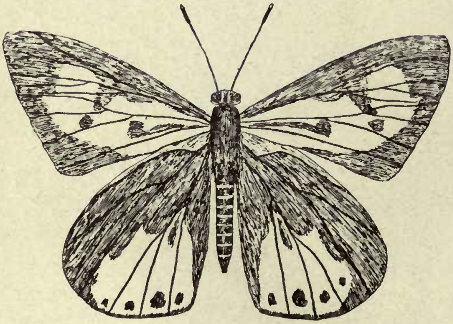


Fig. 21. The Harvester, *Feniseca tarquinius*.
Adult x 2.

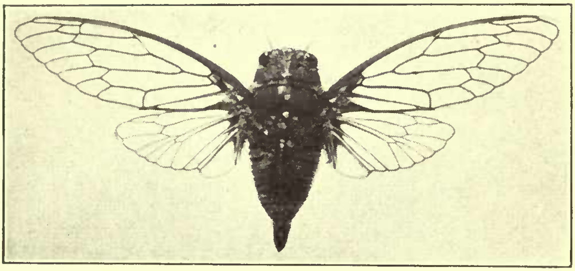
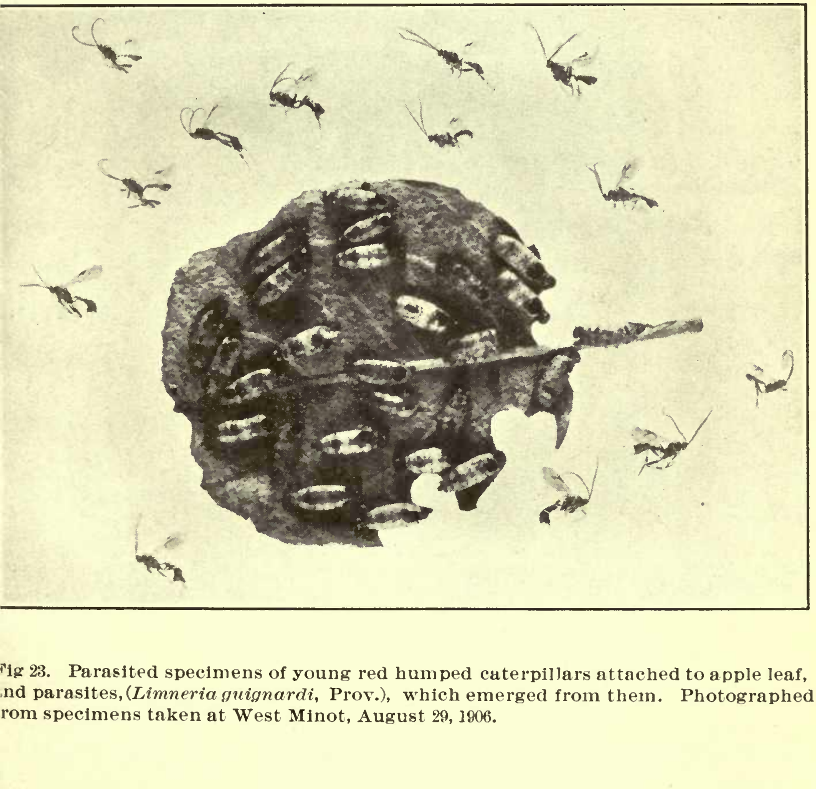


Fig. 22. Harvest fly or Cicada, *Tibicen rimosa* Say. *noveboracensis* Fitch. Very slightly enlarged. Photograph of specimen taken at Orono, July 31, 1906.



ig 23. Parasited specimens of young red humped caterpillars attached to apple leaf, nd parasites, (*Limneria guignardi*, Prov.), which emerged from them. Photographed rom specimens taken at West Minot, August 29, 1906.

Circulars concerning the following insects are available fo distribution and will be sent to any address in the State upo request.

Cecropia moth.
Tussock moth.
Brown-tail moth.
Red-humped caterpillar.
Yellow-necked caterpillar.
Tent caterpillar.
Yellow-edge butterfly.
Elm leaf curl.
White grubs and June beetles.
Cottony grass scale.
Gypsy moth.

University of Maine

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 161 NOVEMBER, 1908

THE SADDLED PROMINENT.

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AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

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BULLETIN No. 161.

THE SADDLED PROMINENT,

Heterocampa guttivitta (Walker).*

EDITH M. PATCH.

The present bulletin deals with a caterpillar outbreak so remarkable that the writer from sheer interest in it put aside other work so far as possible in order to keep in touch with the situation. Although a native insect the species under consideration has but occasionally been met with in the State, and prior to 1907 in numbers so slight that it had not seemed worth any special attention. The specimens of these caterpillars in the Station collection had not been determined except as to genus, never more than 3 or 4 inquiries had come concerning it during any one season and then it was reported only as scattered individuals found on apple trees.

ACKNOWLEDGMENTS.

During 1907 and 1908 numerous items have been sent in from people all through the infested areas which has added to the interest of the investigation. Some of the aid which has been given in this matter is herewith acknowledged in appreciation by the Station. Mr. Allen H. Jordan of Upper Gloucester has furnished pupæ for much of the parasite breeding and has for two seasons acted as guide into infested forest growth with which he is familiar. Mr. Fred R. Jones of Mercer aided materially with the investigation in that part of the State. To Mr. Dayton Edwards is due most of the molting records and the information concerning the conditions at Upper Gloucester, Sebago Lake and North Fryeburg, July 11-July 17. The bird observations were made by Mr. William C. Woods who also aided in the collection of parasites. Mr. Perley Skofield's assistance made much of the insectary work possible.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 31.

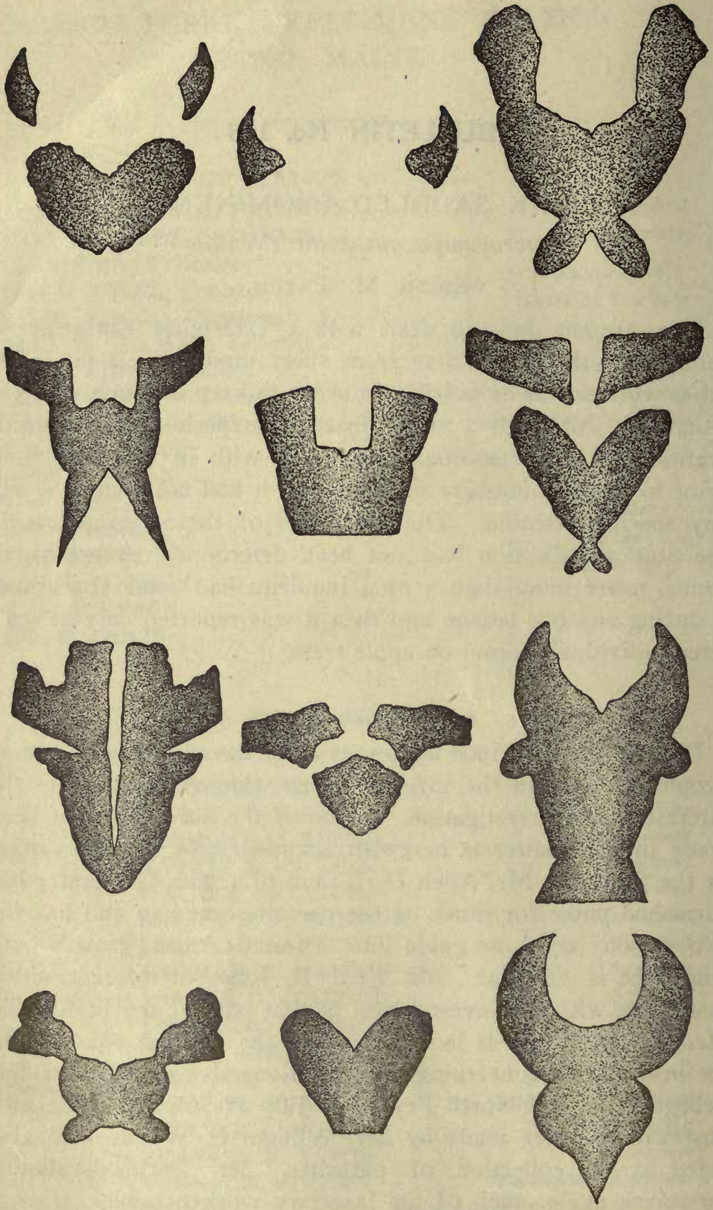

FIG. 14 Saddle marks of saddled prominents in third, fourth and fifth instars, showing a few of the innumerable patterns of this dorsal design. Drawn by Mr. R. L. Hammond.

Discussion of Name "Saddled Prominent."

Since Walker named the species in 1855, *Heterocampa guttivitta* has not attracted enough attention to have been given a common name. It has not, to be sure, lacked variety in classical designations, having been discussed under at least five generic and seven (partly by error) specific names.*

The thoroughgoing attack which it has made on hardwood forests from New York to Maine the past two seasons, however, brings it conspicuously before the public and the lack of a common name is an inconvenience. This inconvenience was met tentatively this season both by the Maine Experiment Station and the Maine Department of Agriculture by the designation "beech prominent," a name very naturally suggested by the noticeable preference of this insect for the beech for the past two seasons in Maine. There is, however, an obvious objection to dubbing a more or less general feeder with the name of its favorite plant, and "beech prominent" did not for this reason seem desirable.

"Antlered maple caterpillar" ** has been suggested, but for this outbreak in Maine, at least, the species has shown a decided preference for beech. The antlers (See Figure 16) are lost after the first few day of its life when it is very tiny so that this would not seem a fortunate popular name for a caterpillar which comparatively few people would even see until the antlers had been shed. Then too, other closely allied species bear antlers as young larvæ, and *Heterocampa biundata,* which retains them through three stages, feeds also upon maple.*

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* *Heterocampa guttivitta* (Walker).

Cecrita guittivitta Walk., Cat. Lep. Het. Brit. Mus., v. p. 992, 1855. *Drymonia mucorea* Herr.-Schaeffer. Samml. aussereur. Schmett., fig. 514, 1856. *Lochmæus cinereus* Pack., Proc. Ent. Soc. Phil., iii, p. 372, 1864. *Misogada sobria* Walk., Cat. Lep. Br. Mus., xxxii, p. 450, 1865. *Heterocampa doubledayi* Scudder, in Harris Ent. Corresp., p. 134, 1867. French, Can. Ent., xii, p. 83, 1880. Sixth Ann. Rep. S. Ill. Normal Univ., p. 661, 1880. Packard, Bull 7, U. S. Ent. Comm. Ins. Inj. Forest Trees, p. 46, 1881 (Quotes French's description). *H. guttivitta* Grote, New Check List N. Amer. Moths, p. 19, 1882. *H. pulverea* Pack., Fifth Rep. U. S. Ent. Comm., p. 159, p. 397, 1890. *Lochmaeus olivatus* Pack., Fifth Rep. U. S. Ent. Comm., p. 39, 1890. *H. pulverea,* Proc. Bost. Soc. Nat. Hist., xxiv, p. 548, 1890 (*H. pulverea by error*). *H. guittivitta* Dyar, Psyche, vi, p. 178, 1891. (Fourth and last larval stages; cocoon and pupa). *H. guttivitta* Smith, List. Lep. Bor. Amer., p. 31, 1891. Kirby, Syn. Cat. Lep. Het., i, p. 564, 1892. *Cecrita guttivitta* Neum. and Dyar, Trans. Amer. Ent. Soc., xxi, p. 207, 1894; Journ. N. Y. Ent. Soc., ii, p. 117, Sept., 1894. *H. guttivitta* Packard. Mem. Nat. Acad. Sci., VII, pp. 230-235. Plates. 1896. *H. guttivitta* Beutenmüller, Bombycine Moths ot Vicinity of New York City. Bul. Amer. Mus. Nat. Hist., X, p. 425, 1898. *H. guttivitta Lugger,* Univ. of Minn. Agric. Exp. Sta. Bul. 61. p. 171 (quotes Beutenmüller's description) 1898.

** Dr. E. P. Felt, Journal of Economic Entomology, Vol. 1, No. 2, p. 150. (Also N. Y. State Ent. 23 Rep't pp 21-23 which appeared while this present bulletin was in press).

The "purple marked forest caterpillar" ** would seem more descriptive of the older caterpillars, though the dark markings on this species in Maine while exceedingly variable were more uniformly reddish brown than purple. The careful larval descriptions of Doctor Packard * and Doctor Dyar *** indicate that purple marked caterpillars were also the exception among those examined by them, the former not mentioning purple and the latter describing it in that color for "a peculiar variety of guttivitta." It is very difficult, however, to strike upon a stable name for a variable species and except for the length of "the purple marked forest caterpillar" this name might be a convenient designation.

The family *Notodontidae* to which the species in question belongs has been popularly named "The Prominents."

"In some species the front wing has a prominence or backward projecting lobe on the inner margin, which has suggested the common name of Prominents for these insects. The name is more generally appropriate, however, for the larvæ, as a much larger proportion of them than of the adults bear striking prominences." ****

We have among related species popular names based upon larval characteristics as "unicorn prominent," "long-horned prominent;" and "saddled prominent," seeming appropriate and convenient enough a name, has been settled upon mutually by the Maine Experiment Station and by the Maine Department of Agriculture, in order that it may bear but one popular appellation in this State.

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* Packard. Bombycine Moths.

** E. D. Sanderson, Newspaper circular. August 1908.

*** Psyche VI, p. 178, 1891.

**** J. H. Comstock, Manual for the Study of Insects, p. 263.

The term "saddled" is suggested by the position of the most conspicuous of the dorsal markings. In different designs this saddle mark appears near the end of the second larval stage and persists through the third, fourth, and fifth stages, that is, it is present from the time the caterpillars are 8 or 9 days old until they are full fed. The saddle mark occurs on the mid dorsal portion of the third abdominal segment, and extends in most cases over the fourth and on to the fifth. Like all the markings in this species the saddle mark is subject to great variation and is sometimes exceedingly faintly traced or absent in the fifth instar. The saddle designs which accompany this discussion are drawn from specimens in the third, fourth, and fifth instars and represent only a few of the countless variations.

We have among the slug caterpillars the "saddle-back caterpillar," *Sibine stimulea* Clem., but with the family name *Prominent* retained there is certainly no danger of a confusion between the names of these two exceedingly dissimilar species.

THE PRESENT OUTBREAK.

About the middle of August, 1907, the Station mail was flooded with complaints of this caterpillar which had made startling inroads in certain localities.* Two of these localities were visited immediately,—a large maple grove at South Leeds and approximately 100 acres of beech growth at Upper Gloucester being found at that time defoliated. The full fed caterpillars were observed to be vigorous and forming apparently healthy pupæ, so that a more serious attack was feared for the present season. With this in view the last of May, 1908, the writer made an initial trip into regions known to be infested the previous August, and frequent trips for observation were taken to certain of these localities from southwestern part of Oxford county to the southern part of Piscataquis county, during the entire caterpillar season. Insectary observations have also been made on this species through the entire life cycle.

While for the most part only enough attention could be paid to this species to accumulate a miscellany of observations, the work has resulted in some definite data not previously known for this species. The fact that for Maine only one brood occurs, the unbroken series of molting records for the same lot of caterpillars, and the notes on parasites, the description of the egg, and several other observations in regard to the life cycle, seasonal history, and habits have not been previously published. In fact from an economic standpoint this species has never demanded consideration * before this present outbreak and except for careful descriptions very little attention has been given it. It is included in Packard's Forest Insects in two places (in both incorrectly determined). This season, however, the attack has occurred seriously in Vermont, New Hampshire, and New York, at least, besides this State; and doubtless much data of interest will come to light over so extended an area.

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* Me. Agr. Exp. Sta. Bul. No. 148. Insect Notes for 1907.

DESCRIPTION OF THE SADDLED PROMINENT.

The descriptions which follow are made entirely from specimens bred in Maine during this present outbreak. They are, however, written with reference to the descriptions of Doctor Packard whose diction is used wherever convenient.

Moth, female. Ground color olive-greenish ashen with cream white patches and black markings. Fore wings with a marginal black line broken at the veins by a pale dot. The marginal fringe is ashen with darker lines extending from the region of the veins giving the wings a border of shallow scallops. There is a submarginal series of 6 to 8 dark spots. Discal mark a curved dark line inclosed in a lunate pale space. In some specimens this pale space extends beyond the median dark zigzag line far enough to enclose the row of submarginal dots. The body is 20 mm. long and the wings expand 40-52 mm. Figure 24 gives the female actual size and presents a better general idea of the markings than a detailed description.

Moth, male. Ground color of both wings darker than with the female, and the markings are less distinctive. Figure 23 was photographed from a particularly dark individual. The body is 20 mm. long and the wings expand 40-45 mm.

Both sexes are variable in markings.

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* *H. guttivitta* was included in a list of 356 apple insects by Lintner (N. Y. State Ent. 11th Rep't, p 265) and an interesting portion of his introductory statement seems, in light of this present outbreak, to sound a note of prophecy:—"It is hardly necessary to state that not all the species herein recorded are to be regarded as specially injurious to the apple tree and its fruit but as each one is known to make it, at times, its food plant from choice (many others will feed upon it in confinement) the least harmful among them may at any time, through such sudden and inexplicable multiplication as is often witnessed in the insect world, become a serious pest."

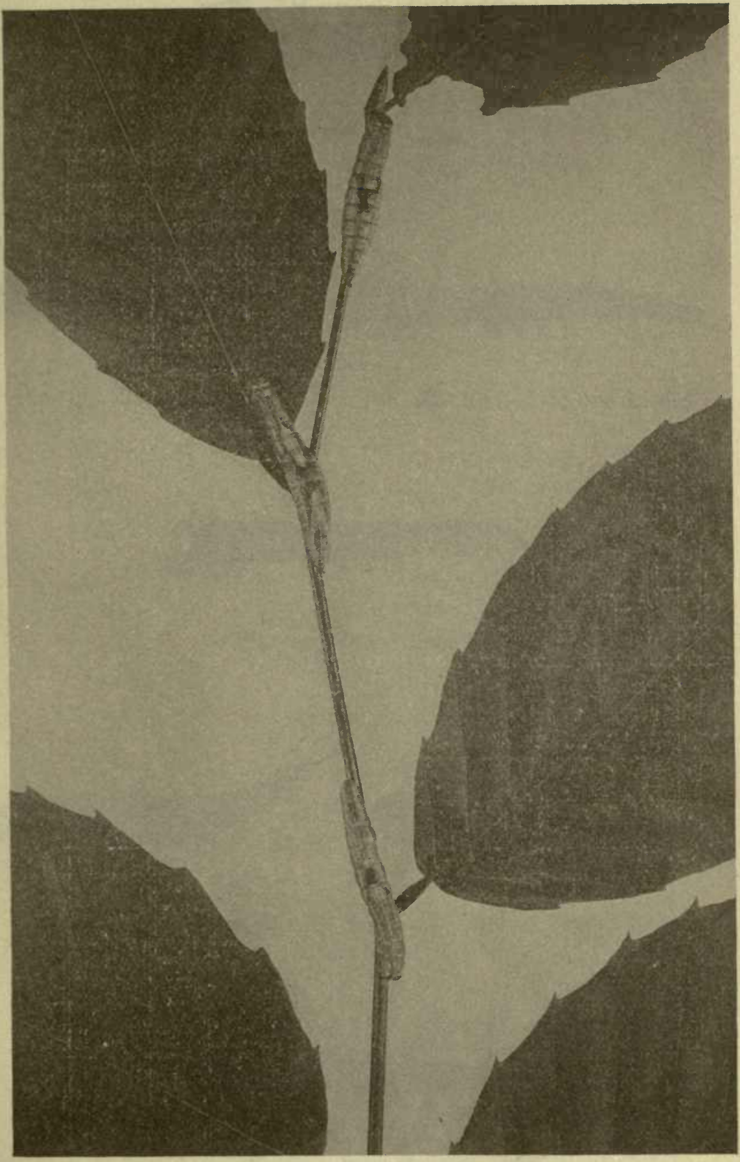

FIG. 15. The Saddled Prominent.

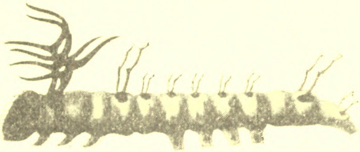

Fig. 16. First Instar.

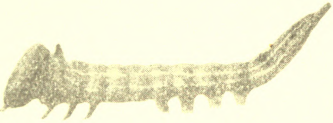

Fig. 17. Second Instar.

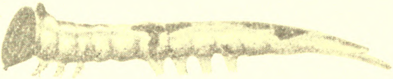

Fig. 18. End of Second Instar.

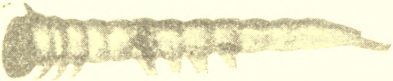

Fig. 19. Third Instar.

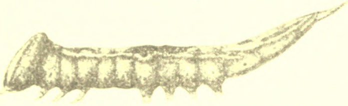

Fig. 20. Fourth Instar.

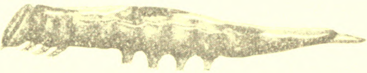

Fig. 21. End of Fourth Instar.

Fig. 22. Fifth Instar.

Larval stages of saddled prominent. After Bridgham. From Plate XXXI Bombycine Moths A. S. Packard. Memoirs of the National Academy of Sciences. Actual size indicated by lines under figures.

Egg. Pale pellucid green, the color of the ribs of the beech leaf. It is circular in outline with a diameter of 1.19 mm. The surface which is applied to the leaf is flat and the exposed surface is an unsculptured convex. The eggs are deposited singly and adhere firmly to the leaf.

Larva. In this stage the insect defies description particularly in the last instars as the dorsal pattern is exceedingly variable. In the first instar the species is characterized by 9 pairs of horns. In the latter instars the caterpillars may be in general described as green with dorsal longitudinal lines of various colors variously interspaced with designs of various shapes and colors. Such a description would at least convey an idea of the most striking characteristic of these larvae,—their high degree of variation as to markings. The most nearly constant of these is a reddish brown spot on the back of the caterpillar. This, the writer has designated as the saddle mark from its position and in some cases its form. The saddle designs figured in the bulletin were drawn from the specimens reared or collected during the summer of 1908, and give a suggestion of the variation of this mark no one of which seems to be exactly like any other. Those caterpillars which cannot find an original design for their saddle evade the responsibility by appearing with no saddle at all. Following is a description which will perhaps serve the present purpose. The form is illustrated by the accompanying figures and the size indicated by the hair line under them.

Larva. First Instar. Figure 16. Body and abdominal legs dull dark red,—head darker red. True legs black. 9 pairs of black horns occur along the mid dorsal line, each situated on a black enameled spot. The first pair just back of the head are much the largest and branched so that they have the appearance of antlers. There are no horns on the second and third thoracic segments or the seventh abdominal segment. The caudal end of the abdomen is held in an elevated position.

Larva. Second Instar. Figures 17 and 18. Body and head dark rose pink. The dorsal horns of the first instar have disappeared and are represented merely by two straight pointed projections on the first thoracic segment and by a pair of very minute points on the first, second, third, fourth, fifth, sixth and eighth abdominal segments. These minute points are black and are situated on a greenish brown mid dorsal spot.

Larva. Third Instar. Figure 19. Body green marked with bright reddish brown, except for slight tubercles representing the prothoracic horns. The body is smooth. The head is conspicuously large at the beginning of the instar with a broad pale reddish band on each side.

Larva. Fourth Instar. Figures 20 and 21. Body green with dorsal reddish brown markings varied. Head large with broad lateral band composed of 4 stripes colored black, white, pink, and yellow.

Larva. Fifth and last Instar. Figure 22. Body usually beech leaf green with a bluish cast though some are brownish and some vary from straw to almost lemon yellow and others from lavendar to deeper purple. (These were insectary caterpillars which had not been exposed to the direct rays of the sun.) The dorsal pattern was not exactly alike in any two of the caterpillars bred, varying from a pale design in whitish yellow in some individuals to a heavy marking in reddish brown or purple in other individuals of the same age. Usually the third thoracic segment bears a dark oblique lateral mark with the ventral end slanting cephalad and the sixth abdominal segment bears a similar mark with a ventral slant caudad. Both these marks are sometimes missing and very often other similar marks are present on other segments.

This species would be a fascinating subject for a study in variation but nothing could really be done with it without the constant service of both a photographer and an artist to reproduce the intricate designs in color as no description could serve to fix them adequately.

Cocoon. Figure 26. The cocoon is formed by a very thin layer of silk usually lining a place hollowed in the leaf mold at the base of the infested tree. Sometimes the cocoon is firm enough so that it can be removed with the particles of earth attached as with the specimen photographed.

Pupa. Figure 25. Within the cocoon is a dark glistening brown pupa about 19 mm. long. Just caudad of the mesoscutum is a curve of 8 dull unpolished tubercles the two at the ends being triangular, and the other six being nearly square. The terminal spines of the cremaster are somewhat boot shaped,—the toe being turned laterad and the heel mesad.

SEASONAL HISTORY.

Packard records the following dates for this species.*

"The eggs were found at Brunswick, Maine, as early as July 3, and it hatched July 11 or 12. Other larvæ, as observed in Maine, hatched about the 8th to 10th of July, feeding on the under side of the leaf, at first eating away a little irregular patch. Stage I lasts 9 days, Stage II probably 4 or 5 days. The last stage is reached a month later, August 9-10; one belated individual occurred on the oak at Providence as late as September 20 to 24.

Riley notes larvæ as occurring in July, and captures of the moths in May, June, July and August."

Doctor Dyar gives the species as "occasionally double brooded" ** and Mr. Beutenmüller says the species "is not common and possibly double brooded." ***

In view of these records the calendar for *H. guttivitta* during the past season's outbreak in Maine is of particular interest.

May 27, 1908, the writer visited a beech growth at North Fryeburg, Maine, which had been stripped by *H. guttivitta* the

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* Bombycine Moths, page 234.

** Psyche VI, p. 179, 1891.

*** Bombycine Moths of Vicinity of New York, p. 426.

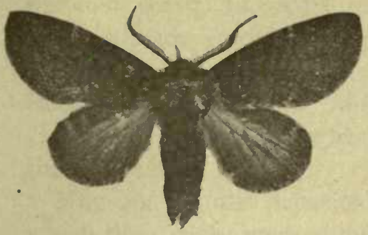

FIG. 23. Male.

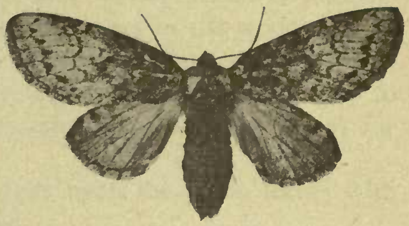

FIG. 24. Female.

Moths of saddled prominent which emerged May 29, 1908. See page 325.

FIG. 25. Pupa.

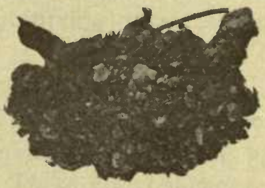

FIG. 26. Cocoon.

See page 322.

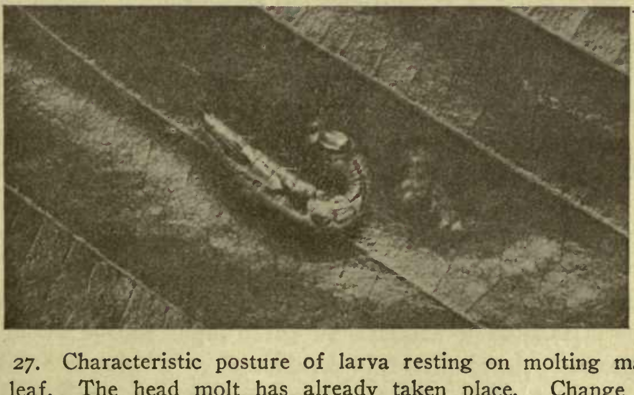

FIG. 27. Characteristic posture of larva resting on molting mat on beech leaf. The head molt has already taken place. Change from fourth to fifth instar. See page 328.

previous season to secure pupæ and was surprised to find the moths already emerging in great numbers in the woods. Several hours were spent collecting pupæ, an easy matter in this thickly infested region. Many moths emerged on the way to Orono but enough pupæ were secured for ample material for the life history cycle.

May 29. Moths deposited eggs upon the beech leaves with which their cages were supplied.

June 7. First instar. Larvæ began hatching and in great numbers.

June 11-12. Beginning of second instar. The larvæ spinning their molting mats on the cage and leaves June 11 and molting during the night.

June 16-17. Beginning of third instar. The mats being formed June 16, and the molt occurring during the night and June 17.

June 23-24. Beginning of fourth instar.

June 30-July 2. Beginning of fifth instar. Last stage.

July 13. The first larvæ observed to be forming pupal cells in the earth provided for them. These pupated promptly.

October 7 the date on which this bulletin goes to press, no moths have emerged from these pupæ though the pupæ are alive as evidenced by their vigorous movements on being disturbed. The pupæ were kept in the insectary under leaf mold where the temperature does not vary appreciably from that out of doors.

This record should settle the question of a double brood for Maine. If moths emerging so early as May with the succeeding larvæ full fed in mid July do not give two generations (and the summer was particularly warm and dry) there would seem to be no possible chance for two broods in this latitude.

That this species is very susceptible to temperature control is evidenced by the fact last winter that from pupæ which were wet and warmed in the laboratory moths emerged December 3, 1907.*

Individuals hibernating in a place which did not warm up early in the spring might easily be a month or so later in emerging which would give late larvæ and conversely exceedingly early individuals to emerge in the spring might perhaps make possible the cycle to the moth stage the same season. Thus farther south two broods may occur.

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* Me. Agr. Exp. Sta. Bul. No. 148, 1907.

Weather conditions may account in part for the fact that in 1908 this species was pupating about the time of month that Packard records newly hatching caterpillars,—mid July; or for the larvæ of the first instar at Upper Gloucester this season on July 11.

The insectary observations were made with ample material. There were 175 female moths which emerged in captivity. A very conservative estimate of caterpillars hatching from the eggs these deposited would be 8,000 or 9,000. (See page 331) No count of the caterpillars in the first instar was made and most of them were destroyed at that time after retaining several hundred for the breeding observations. They were healthy in captivity and an easy species to rear. They were fed entirely upon beech. The foregoing record is for the earliest of the larvæ, a group of about 50 of the first hatching being caged together for detailed data as to molting. For the later larvæ, molting records were not kept.

Pupæ collected at Upper Gloucester, June 1, 1908, and sent promptly to the Station, emerged to a great extent on the way. The last of May to early June seemed a fairly uniform date for the greatest number of emerging moths this season.

As a check upon the insectary data a tour of largely infested areas was made as follows:

July 11 at Upper Gloucester specimens from the first to the fourth instar were found but the majority of them were in the third. They appeared in general smaller than were those reared in the insectary at the same stages,—a fact possibly explained by the food supply which was abundantly furnished to the captive caterpillars while those at liberty at Upper Gloucester had comparatively stripped the beech over 100 acres or more and were in many cases starving to death.

July 15. A devastated area of approximately 150 acres of maple and beech was visited at North Fryeburg where the caterpillars were observed to be a little older than at Upper Gloucester.

July 23. Upper Gloucester was visited again. Where caterpillars had been thick 12 days before very few were now to be seen. In some places they were traveling up and down the trunks of stripped trees and it was in such places that the predaceous Podisus (see Fig. 37) was seen to be busy stabbing the larvæ and the pile of dead and half sucked caterpillars at the bases of trees where these bugs were at work gave good evidence of their appetites. Some larvæ were dying evidently from exhaustion and starvation after traveling up and down many trees and finding no food. Nearer the outskirts of the devastated area the caterpillars were faring better as they got off into fresh growth and were feeding vigorously. Those which were observed were in their fifth (last) instar.

July 24. Sebago Lake, Cape Raymond. The caterpillars were in their fifth instar, healthy and feeding.

July 27. Norridgewock. Caterpillars in the fifth instar, some feeding and some pupating, for the most part healthy.

July 28. Mercer. Pupated in some localities. In others caterpillars in the fifth instar feeding, a few beginning to die. (See a contagious fungus disease p. 344).

July 31-August 1. Norridgewock. Some healthy caterpillars feeding; many sick and dying.

August 3-4. Mercer. Dead caterpillars present by thousands and only a few live ones seen in two days.

Aug. 5-7. Norridgewock. Collection of pupæ which were in certain localities numerous.

August 8. Sebago Lake. *Heterocampa guttivitta* had already pupated in apparently healthy shape. Other species of larvæ which were about at the time were fungus attacked.

August 10. East Sangerville. Caterpillars still feeding, though many were full fed in this locality July 26.

August 14. Buckfield. Larvæ still feeding.

SEASONAL HISTORY SUMMARY.

For Maine the saddled prominent has but one brood. The moths in 1908 emerged in greatest numbers late in May and early in June. Oviposition begins soon after mating which occurs the first night after emergence.—The eggs hatch in about 9 days and the larvæ become full grown in 5 weeks (or more according to weather conditions and food supply). During this time they molt four times. The full grown larvæ enter the ground for pupation. In Maine this season pupation took place from mid July to late August, the majority of larvæ burying late in July. They pass the winter in the pupal stage, under the leaf mold and the moths emerge in the spring.

HABITS.

The eggs are deposited singly by the female which in captivity applied the eggs to both sides of the leaf. From the reason that during both years over the whole range of the infestation the *tops* of the trees were stripped first and then the lower branches it is to be concluded that the moths by preference deposit the eggs upon the upper leaves. Perhaps the same tendency to fly high may account in part for the fact that the hillside forests were in general more largely attacked than the lowlands, which was noticeable throughout the infested districts.

An interesting feature was noticed in the feeding habits of the larvæ. The young caterpillars just hatched fed, as do the young of many species, from the surface of the leaf skeletonizing it in spots by nibbling out the parenchyma and leaving even the finest veins untouched. (See Figure 28). This habit was continued through the first instar but after the first molt the caterpillars migrated to the margin of the leaf and the meals during the second instar were obtained by eating down between the veins as indicated by Figure 29. In the third instar the feeding habits of the caterpillars is represented by Figure 30. After that Figures 31 and 32 are significant illustrations.

The saddled prominents do not cling tightly to the leaf or branch. Even in the first instar the caudal portion of the body is elevated,—the species from the first observing that characteristic family trait. A slight jar will dislodge the caterpillars from their hold and bring them rattling to the ground. (See also Combatative Measures page 349). They then climb the trunk and go to work again.

Before each of the four molts they carefully spin a thin, broad resting mat where they cling during the molt. At such times the larva usually waits with the head curved to one side as shown in Figure 27 where it will be noticed that the head molt has just occurred.

The full grown larva drops or climbs to the ground and constructs a cell in the earth or under the leaves at a distance of one to 3 inches below the surface. This cell is oval and is lined

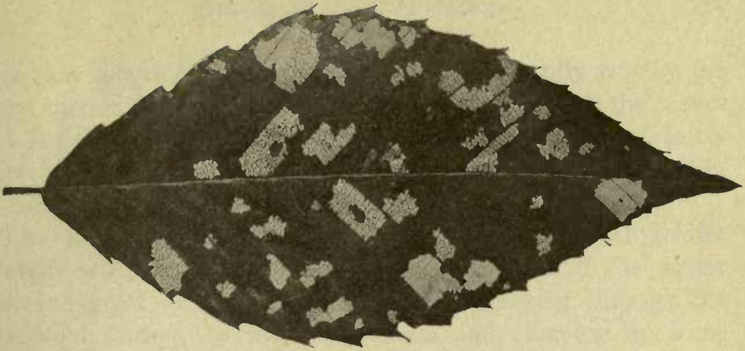

FIG. 28.

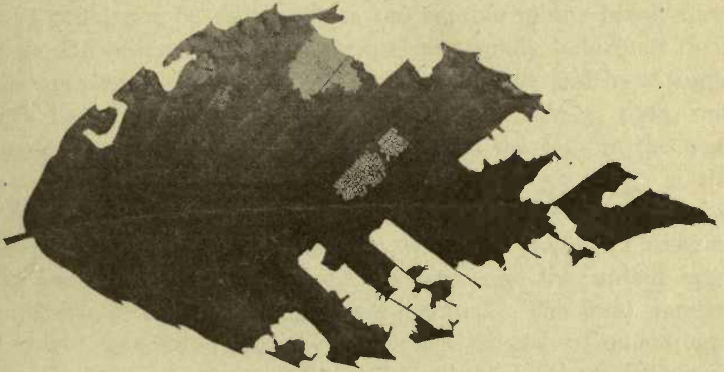

FIG. 29.

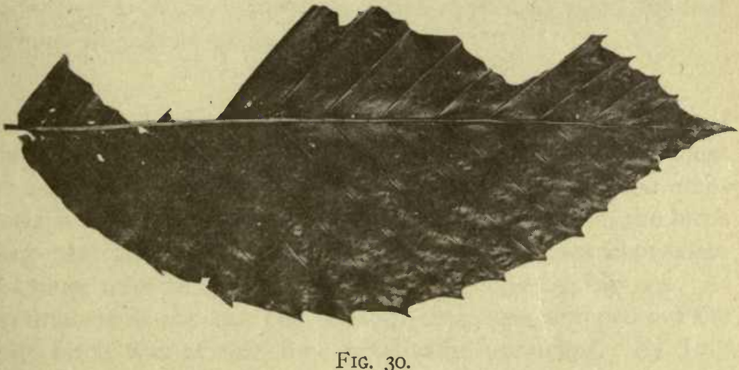

FIG. 30.

Beach leaves showing work of saddled prominent in first, second **and** third instar respectively. Reduced. See page 328.

by a thin spinning of silk. The structure is hardly worthy the name cocoon as it is easily broken in throwing back the leaves and the loose pupæ exposed. Sometimes, however, a fairly stable cocoon is constructed and such a one to which particles of earth have adhered is shown in Figure 26.

The insect after remaining in the pupal stage all winter emerges with the warm spring days. On May 27 the writer observed great numbers of these moths breaking through the leaf mold during the warm afternoon and creeping up some convenient object while their wings expanded.

During captivity the moths mated the first night and began laying eggs soon afterward. The length of life of an individual moth could not be estimated as the captive moths break their wings and otherwise disable themselves usually before all their eggs are deposited. As to the number of eggs laid by a single moth the following record is of interest. June 3, 1908, one female freshly emerged was dissected and the eggs in the ovarian tubes were counted. They varied from 55 to 75 in the different tubes of which there are 8, and the total number for this one moth was approximately 500 eggs. Later 12 females that had died in the cage were dissected and the unlaid eggs remaining in the egg strings were counted. The total number of unlaid eggs was 629 giving an average of 52+ of unlaid eggs to each moth. In some individuals only 5 or 6 eggs remained. In 3 individuals the number of unlaid eggs was between 125-150, however, a condition doubtless due to the moths beating themselves to death before they finish depositing eggs, in their attempts to get out of the cage.

FOOD PLANTS.

Beech leaves have been unquestionably the favorite food of this species during the two years attack in Maine. Over about 800 acres on Frye's Island, Sebago Lake, and about 800 acres on Cape Raymond, the beech was completely stripped, the birch being taken later. At Upper Gloucester the beeches were taken first these trees being defoliated over 100 acres by July 11. At this time maple and oak had been in some cases stripped but the white birch was at that time practically untouched. By July 23, however, the birch had succumbed also.

Isolated maple groves as well as maples present with beech in forest growths were stripped often by the saddled prominent alone and sometimes helped out by the green striped maple caterpillar, *Anisota rubicunda,** which has been for two years very numerous. Similarly the attack by the saddled prominent on the oaks was reinforced by the rosy-striped oak-worm, *Anisota virginiensis.**

As to what happened to apple orchards in the infested districts Figure 32 is sufficient explanation.

Yellow birch seemed avoided at first and several reports came in "everything stripped but yellow birch" but larvæ of this species were seen actively feeding upon the yellow birch at East Sangerville and elsewhere later in the season.

Sumac was in several instances reported stripped but in every case investigated by the writer this was due to an undetermined small green caterpillar which made a general raid of the sumacs this season.

Saddled prominents were observed to be feeding also upon witch hazel, poplar, blackberry, mountain maple, spirea, cherry, and undoubtedly a full list of food plants would be very long.

The order in which various species of trees were taken seemed to vary in different localities but everywhere the beech was given preference.

The following extracts from letters give the food plants most attacked and are indicative of the extent and time of most conspicuous infestations. In each case the inquiry was accompanied by specimens of the saddled prominent.

July 18, 1908. Douglas Hill, Cumberland County, Maine. "Sunday they stripped fully 50 acres of forest trees here and are still at work very rapidly. They are also on apple trees."

July 28. Dover, Piscataquis County. "I am sending several worms taken from maple trees. They are eating the leaves from the tops or seem to work more in the top. May work downward later as I have just discovered them."

July 14. Bridgton, Cumberland County. "Some green worms are covering our apple trees in large numbers and are doing great damage."

July 16. Naples, Cumberland County. "What species of worm are these on nearly all hardwood and fruit trees? Beeches seem to be the ones they prefer."

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* See Maine Agric. Experiment Station Bulletin No. 162 Insect Notes for 1908.

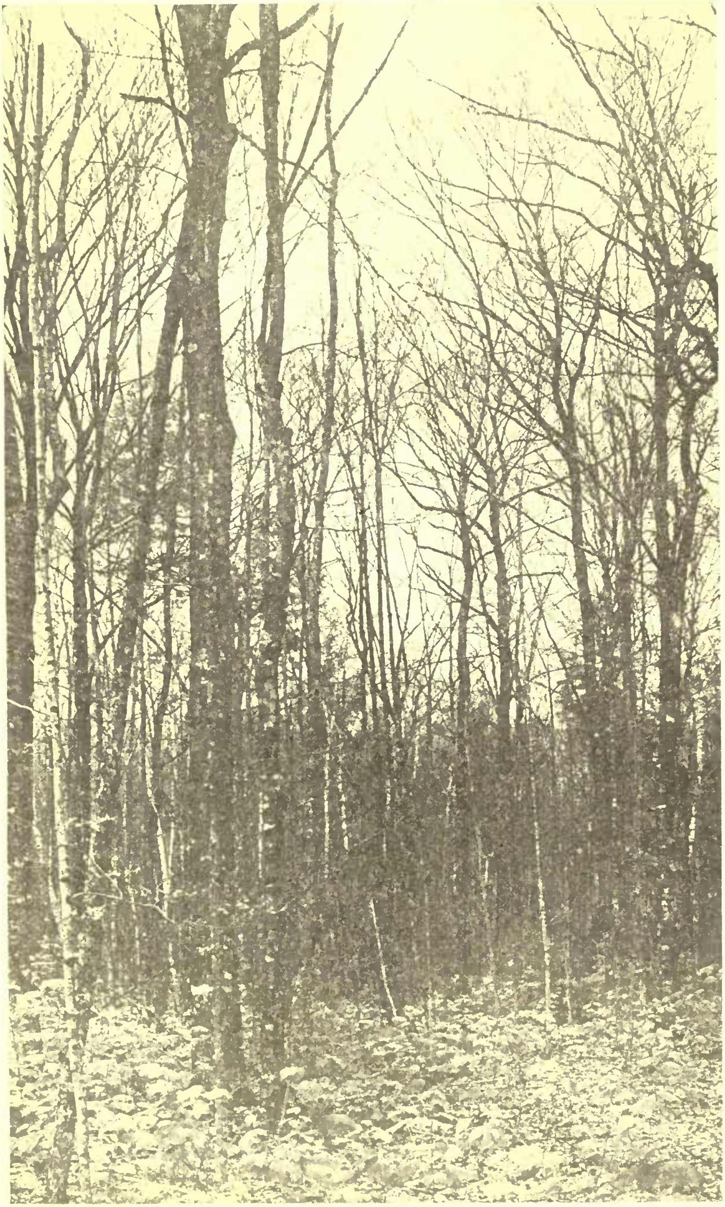

FIG. 31. Work of the saddled prominent in beech growth. Photograph taken at Upper Gloucester, Me., July 23, 1908.

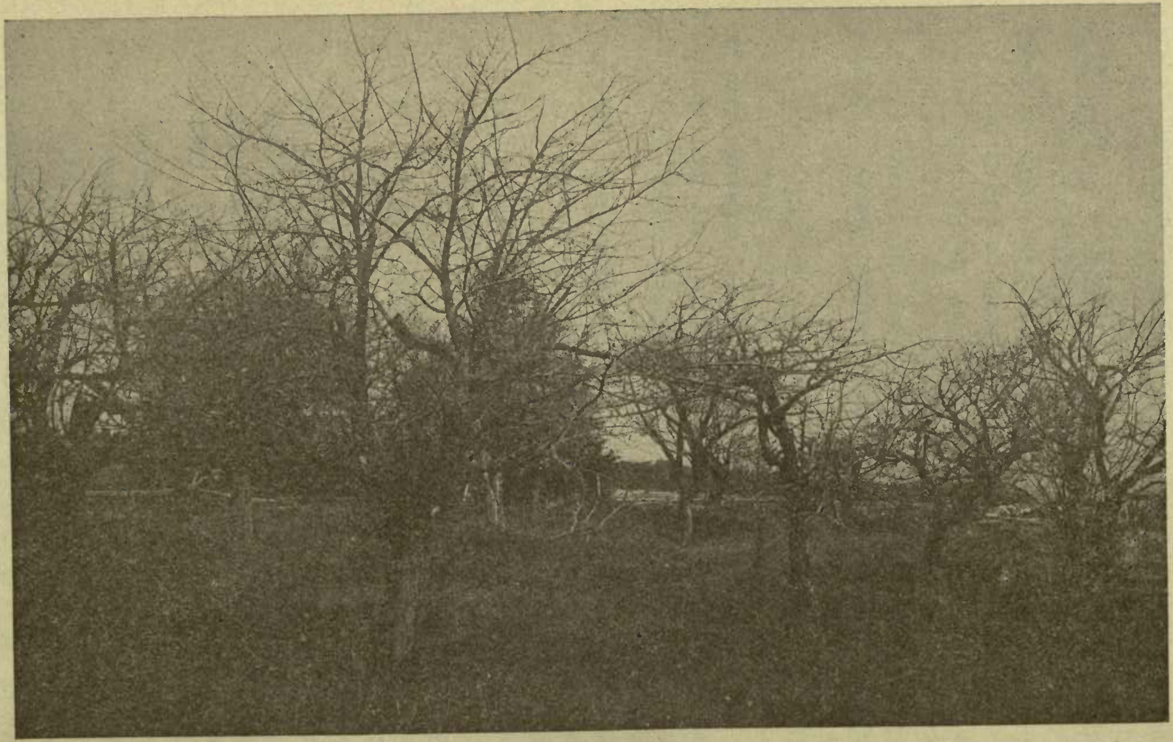

FIG. 32. Orchard stripped by the saddled prominent, on the estate of J. H. Jones & Sons, Hampshire Hill, Mercer, Me., July 20, 1908. Photograph loaned by Mr. Fred R. Jones.

July 16. Lovell, Oxford County. "The green worms have stripped whole orchards of leaves."

July 19. Sebago Lake, Cumberland County. "I first saw these worms in this section last spring when they began attacking the beech, birch and maple on several hundred acres. This year they have become much worse."

July 20. New Sharon, Franklin County. "These caterpillars have eaten off all the foliage from many of the trees, both apple and hardwood. They are especially prevalent on beeches."

July 20. Stark, Somerset County. "These caterpillars are stripping the hardwood trees in this part of the town."

July 20. N. Waterford, Oxford County. "Some green worms are eating *all* the leaves on the apple trees and take the maple and beech."

July 20. Shapleigh, York County. "They have stripped the leaves from 100 acres of forest, and are also working on fruit trees."

July 20. Livermore Falls, Androscoggin County. "I send specimens of green worms which are devouring both shade and fruit trees."

July 21. Lovell, Oxford County. "Am sending a box of *Heterocampa guttivitta.* They have proved very destructive in this vicinity. Several hundred acres having been traversed by them and are almost devoid of leaves. Our orchard is practically ruined for this year at least. Our shade trees are bare as winter except elm and oak."

July 21. Livermore Falls, Androscoggin County. "Several hundred acres have been so defoliated that they present a brown appearance like that of bare trees in winter. The caterpillars seem to prefer the beech and birches, but are also very numerous on maples and oaks and may be found on other trees."

July 22. Madison, Somerset County. "The worms are doing considerable damage, working chiefly in the top branches."

July 22. Norridgewock, Somerset County. "They are partial to beech and yellow birch."

July 22. Harrison, Cumberland County. "The forests in the south part of Harrison and the adjoining town of Naples are in an alarming condition. The beeches are as bare as in December. White birches, oaks and maples are suffering severely. Apple trees are in a leafless state also. The same condition prevails across the lake in Bridgton."

July 23. N. Waterford, Oxford County. "I am sending you worms that belong to an army which are destroying all the hardwood save the poplars within about seven miles of here. Last year they started to eat in the town of Sweden cleaning up the woods so that with the exception of the poplars and evergreens they looked as bare as in late fall. This year they ate everything that leaved out in the old neighborhood and began to move toward us through the woods in great quantities. They are moving half a mile a day. They seem to crowd along the ground in swarms as soon as they strip one section of woods."

July 23. Bethel, Oxford County. "The worms have eaten the leaves all off about 500 cords of wood and they are so thick they can be gathered by the bushel."

July 23. Hiram, Oxford County. "I send you specimen of a worm that is eating the hardwood growth, stripping the trees over thousands of acres in a place."

July 24. N. Leeds, Androscoggin County. "Forests look as though a fire had swept through."

July 24. Freeport, Cumberland County. "Beech trees seem to fare the worst."

July 24. Shapleigh, York County. "A caterpillar that is destroying acres of woodland and apple trees."

July 27. Wiscasset, Lincoln County. "I am sending you green worms which have stripped the beeches and yellow birches completely and have nearly stripped the white birch and are now beginning on the maple."

July 28. Sebago Lake, Cumberland County. "They are eating beeches, oaks and birches. White maple and sugar maple have escaped so far. They begin at the top of the tree and work down until there isn't a leaf left upon the tree, they then drop to the ground with a thud and crawl to some other tree. The woods are full of them on the ground and they are traveling at a fearful rate."

July 29. Ross Corner, York County. "The Prominent (*H. guttivitta*) is doing the most damage, the one I send you on oak (*Anisota virginiensis*) comes next and the maple leaf caterpillar (*A. rubicunda*) last. Probably 100 acres of trees are all bare."

July 31. So. Paris, Oxford County. "They seem to prefer beech, birch and maple. They strip a tree clean of leaves and take tree after tree."

August 1. Fryeburg, Oxford County. "The wretched infestation of these worms make life in the country difficult and destroy the pleasure of my hitherto beautiful summer home."

August 1. Gardiner, Kennebec County. "Worms that are destroying the foliage of beech, maple and birch in the forests."

August 5. Sebago Lake, Cumberland County. "I was in the woods yesterday and there are scarcely any of the Prominents to be found in the trees now."

DEGREE OF INJURY DUE TO THE SADDLED PROMINENT.

The question uppermost in the minds of owners of infested woodland is whether the stripped trees will die. While it is not possible definitely to predict the degree of injury caused by such an attack, the following statements are of interest in this regard. Weather is one controlling factor, hard winters, excessive drought, or other unfavorable climatic conditions occurring at the time of such a severe stripping of trees increase the danger of fatal results. Under ordinary conditions some species of deciduous trees will stand being stripped for 2 consecutive years, and recover from the shock. If other conditions are particularly favorable a 3 years seige may not prove fatal. Some species of trees will stand what others cannot. The beech growth at Upper Gloucester and North Fryeburg which the writer had under observation was thoroughly stripped in 1907 and leaved out heavily and well the following spring. At South Leeds, Mr. John O. Bates, at whose place a large maple grove was completely stripped by the saddled prominent both in 1907 and 1908 wrote on September 16, 1908: "The old growth maple all leaved out in good shape last spring. The leaves on the young maple tops were a pale yellow. This year the grove was stripped as bare as winter about the first of August. Last year the trees did not leave out again after being stripped. This year the maples have all leaved out and some of the limbs of the beeches have leaved out."

Other reports that the trees, particularly the maple, were releaving came from various parts of Maine during late August this year.

The fact that in general the infested districts were stripped about 2 weeks earlier this year than last seems to be due to the greater number of caterpillars this season, many growths being devastated before the caterpillars were nearly grown. This was an unfortunate thing for the caterpillars as, except for such as could reach fresh growth, there was nothing for them to do but "drop out of the trees and keep going up until they died" as one observer put it.

NATURAL ENEMIES OF THE SADDLED PROMINENT.

Prophecy as to the condition of the caterpillars another season is as difficult as predictions concerning the state of the trees. There are, however, more definite statements to be made in this case.

INSECT ENEMIES.

Last year over widely separated regions the saddled prominent pupated in an apparently perfectly healthy condition. Predaceous bugs and beetles were numerous and fed upon the caterpillars to a considerable extent. Two counts were made for the proportion of parasites from pupæ collected this spring. From 255 pupæ collected at Upper Gloucester June 1, 1908, 190 moths emerged, and 15 parasites, the cause of death of the other 50 pupæ was perhaps largely due to injury in transmission or handling in laboratory. From 176 pupæ collected May 29 at North Fryeburg, 153 moths emerged and 5 parasites, the remaining 18 died probably from injury in transmission. In 1908 particularly about August 1, hymenopterous parasites were very abundant in the woods infested by the saddled prominent. Concerning about 40 species there is so far only such circumstantial evidence that they were present in regions infested by the saddled prominent and further observations will be made for these another season. *Pimpla pedalis* which passed the winter in the pupa of its host was bred by the writer from pupæ of *Heterocampa guttivitta* collected last spring and *Ichneumon sublatus* * similarly bred was present this season in great numbers from North Fryeburg to Norridgewock, and was without question the most beneficial of the hymenopterous parasites.

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* Determined by Mr. Crawford through the courtesy of the U. S. Bureau of Entomology.

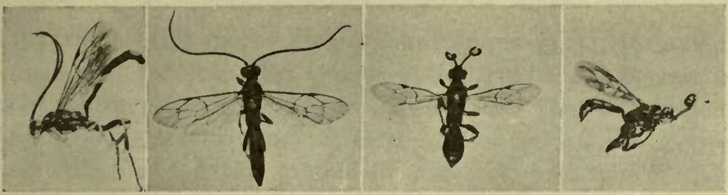

FIG. 33. Male. FIG. 34. Male. FIG. 35. Female. FIG. 36. Female.

Ichneumon sublatus. The most beneficial parasite of the saddled prominent. See pages 340 and 343.

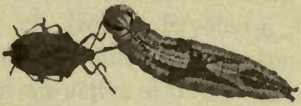

FIG. 37. *Podisus modestus.* Predaceous bug stabbing the saddled prominent. See page 343.

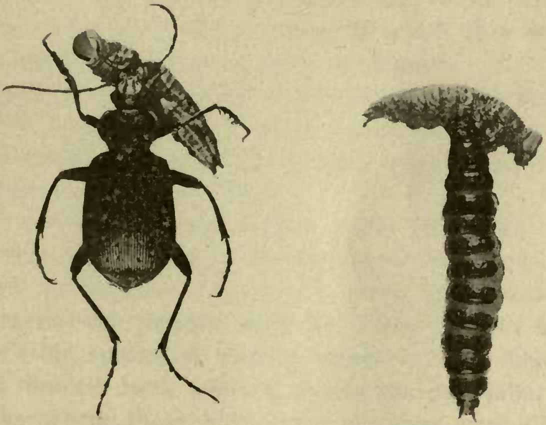

FIG. 38. Adult. FIG. 39. Larva.

Calosoma. Predaceous beetle feeding upon saddled prominents.

Both sexes of this species are given as Figures 33, 34, 35, and 36. *Ichneumon sublatus* also emerged the middle of September from pupæ collected at Norridgewock the first of August. How many generations a year there are for *sublatus* in connection with the saddled prominent was not ascertained. The only seasonal data which can be given is that it passed the winter in the pupa of its victim and emerged early in June, that it was on the wing in great numbers (evidently freshly emerged individuals) the first of August in the infested regions and that the species also emerged in mid-September from pupæ of the saddled prominent. Of the various predaceous wasps, apparently attracted by the saddled prominent, species of Ammophilas were particularly abundant.

The larvæ and adults of *Calosoma* were numerous in the infested woodlands at North Fryeburg, Upper Gloucester, Norridgewock and Mercer during the season. Both the beetles and larvæ carried on an active warfare against the caterpillars and were found climbing the tree trunks for their prey though their supply of food was largely taken from the ground or a foot or two up the trunk. One of these beetles was, however, found on the branches of a small tree. Figures 38 and 39 illustrate two stages of this species.

The larvæ of *Calosoma* are also active in feeding upon the buried pupæ of the saddled prominent and were particularly fond of the fresh pupæ the contents of which they were frequently found to be devouring early in August.

Pterostichus lucublandus was especially abundant last spring under beech trees where the pupæ were hibernating. These and other common ground beetles unquestionably take their part in feeding upon these caterpillars.

Of the predaceous bugs which were numerous, *Podisus modestus* was most active in feeding upon the caterpillars of the saddled prominent. Figure 37 gives this species in a fairly characteristic position with its beak plunged into the caterpillar (this species it usually attacks a little behind the head) and braced back while it drains the caterpillar fluids. Tree trunks where these bugs were working were decorated with dead caterpillars half sucked and hanging limp like an inverted U, and little heaps of dead caterpillars at the base of the trees testified to the ability of these blood thirsty bugs.

Some undetermined species of predaceous bugs were found near the saddled prominents but none were so numerous as *Podisus modestus*. As this bug also feeds upon the caterpillars of the brown-tail moth * it should be recognized as a benefactor of considerable significance.

No effort was made to secure evidence in regard to the host of insect eating animals. Mr. Curtis A. Perry, Bridgton, reports a pair of pet skunks as being very fond of the saddled prominents, eating them voraciously.

STARVATION.

Before the middle of July at Upper Gloucester and other badly infested places large areas had been already stripped. This happened in many cases before the caterpillars were ready to pupate and though the caterpillars sought new feeding ground, as was evidenced by stripped orchards (see Fig. 32), hordes of the caterpillars never reached suitable food and died of starvation. These starving caterpillars would drop from one defoliated tree and climb others only to find that no food awaited them. Many climbed trees they could not eat when nothing remained for them but to drop or climb down and try another. Figure 40 shows a mass of such caterpillars that had congregated about the base of a hemlock tree the foliage of which they could not eat.

CONTAGIOUS DISEASE.

Where excessive numbers of caterpillars are present in one place, favorable conditions arise for the spread of disease. Late in July and in early August various species of caterpillars were attacked by a disease and in some instances practically the whole infestation of saddled prominents was wiped out. At Mercer and elsewhere countless thousands of these caterpillars died within a few days. They lay in heaps about the bases of trees, in masses about stones, and hung limp where they had fallen across the branches. Specimens of these caterpillars were examined by Doctor Lewis, Associate Plant Pathologist of this Station, who found that the disease was due to a fungus parasite but that bacteria set in among the sick caterpillars and hastened their decay. The destruction of the bodies

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* See Me. Agr. Exp. Sta. Bul. No. 162 Insect Notes for 1908.

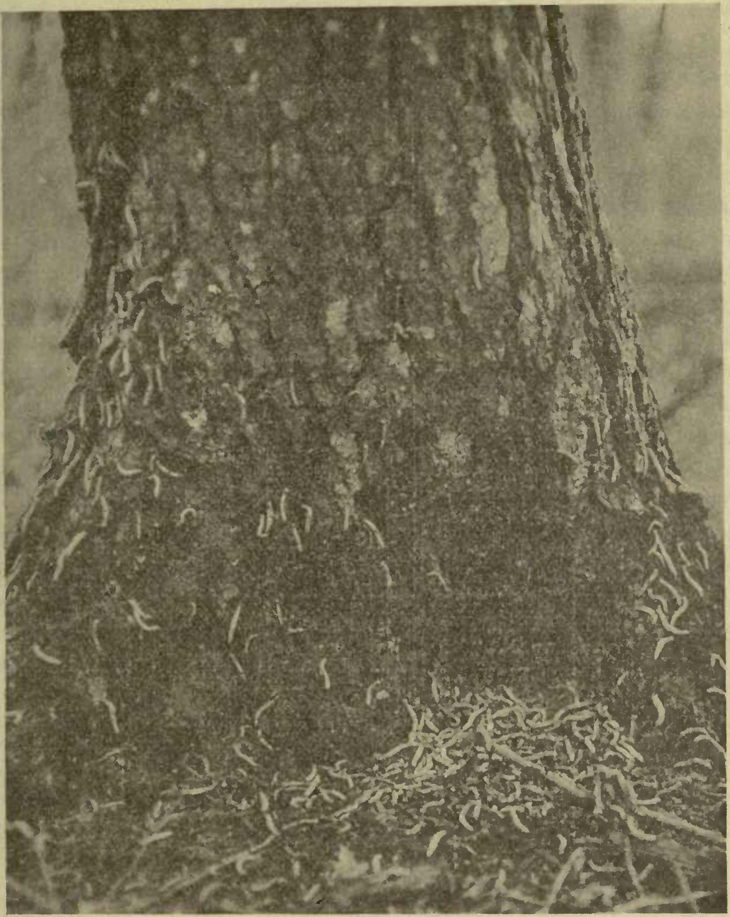

FIG. 40. Starving saddled prominents congregated about base of Hemlock tree, the foliage of which they could not eat. Photograph taken in stripped beech growth upper Gloucester, Me., July 23, 1908. See page 344.

was thus so rapid that after a few days of heavy stench, nothing remained of the plague-stricken caterpillars.

In localities where the caterpillars died this season in this wholesale manner, it would seem that little need be feared from caterpillar attacks for the coming year.

In what manner the fungus disease started is not known. Possibly it found entrance among the wounded caterpillars that predaceous bugs had stabbed. In one or two localities there seemed to be some indication that such was the case. Once well started it would not be difficult for the disease to spread rapidly for the fungus penetrates throughout the body of the caterpillar, and the spores are thrown to considerable distance in all directions so that they light upon caterpillars below, or upon parts of the tree over which healthy caterpillars would travel. *Podisus modestus* was observed repeatedly in close proximity to diseased caterpillars, and it is not unlikely that such bugs would transfer fungus spores from sick caterpillars to healthy ones.

It is worth recording in this respect that this fungus outbreak came in a dry season. At Hampshire Hill, Mercer, for instance, it had rained but twice in the month (July 17 and July 27) previous to the height of the fungus disease which occurred July 28 to August 1. This severe fungus attack at Mercer occurred over an area the altitude of which was from 680 to 1020 feet, reaching the summit of the hill. Although it was a particularly dry season, various species of caterpillars were attacked by fungus all over the State about this time, though in many localities the saddled prominents had become full fed and safely pupated before the fungus developed.

BIRD ENEMIES.

As a rule soft bodied caterpillars are soon checked by birds. In order to form some estimation of the role birds were taking in the present outbreak, observations of badly infested areas were planned for this year. This could not be carried out until late July and early August, and it chanced that each place selected for the desired data was experiencing a wholesale fungus attack which naturally interfered with bird diet.

The following list of Maine birds, however, gives species which are undoubtedly beneficial. Of these 45 are reported as observed eating hairy caterpillars * in Massachusetts and the remaining 8 related more northern species would without doubt have the same habit. Any bird that will eat a hairy caterpillar will take a naked caterpillar like the saddled prominent with relish.

Yellow Billed Cuckoo, Black Billed Cuckoo, Hairy Woodpecker,** Downy Woodpecker,** Yellow Billed Sapsucker, Northern Flicker,** Kingbird,** Crested Flycatcher, Least Flycatcher, Phoebe, Wood Pewee, Blue Jay, American Crow,** Red Winged Blackbird, Baltimore Oriole, Bronzed Grackle, White Throat Sparrow, Chipping Sparrow,*** Song Sparrow,** Field Sparrow, Junco,** Towhee, Rose Breasted Grosbeak, Indigo Bunting, Scarlet Tanager, Cedar Waxwing,** Red-Eye Vireo,*** Warbling Vireo, Solitary Vireo,*** Yellow Throat Vireo, Black and White Warbler,** Nashville Warbler, Northern Parula Warbler, Yellow Warbler,** Black Throated Green Warbler, Black Throated Blue Warbler, Myrtle Warbler, Magnolia Warbler, Chestnut Sided Warbler, Ovenbird, Northern Yellow Throat, Northern Water Thrush,** Redstart, Catbird, Brown Thrasher, Winter Wren, White Breasted Nuthatch, Red Breasted Nuthatch,** Chicadee,** Wilson's Thrush,** Hermit Thrush,** Robin,*** Bluebird.

In recording the efficiency of birds as natural enemies to the saddled prominent and other caterpillars, the domestic fowls should not be scorned. Turkeys and hens though not applicable to forest conditions are exceedingly helpful in the orchard or about shade trees. By way of example may be cited a hen of Buckfield which ate without much pause 60 of the caterpillars which dropped from a tree that was given a sharp rap. A case to the point also is recorded by State Entomologist E. F. Hitchings * concerning a chicken weighing when dressed 1 3-4 pounds. The crop of the little fowl was so distended that its contents were examined curiously and were found to consist of 75 full grown caterpillars compactly disposed.

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* Forbush, E. H. Useful Birds and Their Protection.

** Seen in stripped woodlands in Maine.

*** Actually observed feeding on saddled prominent.

* Maine Dept. of Agric., Augusta. Circular of Information on Forest Insects, 1908.

Combatative Measures.

ORCHARD AND SHADE TREES.

For the orchard or shade trees there are several practical measures which have proven successful the past season in preventing serious injury from the saddled prominent.

Spraying. This species is susceptible to arsenical poisons and the caterpillars readily died on apple trees which were thoroughly sprayed. Arsenate of lead or Paris green will kill these caterpillars and should be applied as soon as they begin appreciable work. Applications from the middle to the last of June would probably get all these caterpillars which hatched upon the trees. In case a migration to an orchard from an infested forest growth is feared, the orchard should be sprayed as soon as the caterpillars begin to travel in search of fresh food. If trees not already attacked are banded with a sticky substance, the ascent of caterpillars up the trunk will effectually be prevented.

Jarring and banding. The saddled prominents are readily shaken from the branches. The writer repeatedly has seen trees effectually cleared in this way for the past two seasons. Small trees can be shaken from the ground. With larger ones a boy can be sent among the branches to shake or give them a sudden jar, a proceeding which should begin with the top, of course. The cool of the morning is the most propitious time for jarring.

The caterpillars once dislodged, their reclimbing can be prevented by banding. The trunks of the trees are protected with a sticky band. A band of tarred paper thickly smeared with equal parts of lard and sulphur has proven helpful in such cases. This mixture should not be applied directly to the bark of the tree as there is danger of injury, but with the tarred paper it is safe and effectual. Tar hardens so quickly that it has not proven satisfactory in several cases where it has been tried this season.

A material useful in certain phases of the gypsy caterpillar campaign and sold under the name of Tree Tanglefoot has been recommended by this Station during the present seige of saddled prominents. "This substance consists principally of resin softened by the admixture of suitable oils. It is quite similar to that used in the manufacture of adhesive fly-paper, seems to possess the merit of not injuring the trunks of trees, and is very effective in checking the ascent of caterpillars thereon." * Where the number of caterpillars jarred from the trees is excessive it is expedient to kill them. A hand spray charged with kerosene or gasoline is a useful means to this end.

Fowls and Pigs. Hens will devour these caterpillars greedily (see page 348) and if given the range of an orchard will eat great numbers of the caterpillars which drop to the ground or descend to pupate. Of course, where such an excessive infestation occurs as during the present season, it would not do to depend upon hens entirely but they would prevent great numbers from entering the ground to develop into next season's moths. A flock of turkeys would display even more commendable ability in this respect.

Pigs pastured in an orchard will, by rooting up and eating the pupæ, prevent great numbers of saddled prominents and other moths from emerging and depositing eggs for the following season.

FOREST TREES.

For such phenomenal outbreaks as the present no artificial measures are practical in forest growths. If the saddled prominents were likely to appear in excessive numbers year after year, wholesale spraying or other combatative measures might be advisably applied as with the gypsy caterpillars. But the saddled prominent, like other native species, is ordinarily held in check by birds, insect enemies, field mice and other animals which feed upon it in its various stages, by fungus diseases or by weather conditions. A moth ordinarily so guarded has never been known to remain uncontrolled by natural agents for more than a few years in succession, and in extensive woodland growths there is in this case apparently nothing to be done except to wait for natural conditions to readjust themselves.

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* A. H. Kirkland. Second Annual Report of the Superintendent for Suppressing the Gypsy and Brown-tail Moths, page 150.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 171. NOVEMBER, 1909.

THE PINE-LEAF AND THE GREEN-WINGED CHERMES

A bulletin on Maine Chermes now in process of preparation is of technical character and will not be sent to the general mailing list of the Station. The two species discussed in this bulletin, however, are of economic interest in the State and for this reason the following popular account of them is prepared for immediate distribution in Maine. The bulletin on Maine Chermes will not be ready for distribution until next year.

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BULLETIN No. 171.

THE PINE-LEAF CHERMES
AND
THE GREEN-WINGED CHERMES.*

EDITH M. PATCH.

THE PINE-LEAF CHERMES (*Chermes pinifoliæ* Fitch).

On account of recent troubles, varying in nature and importance, of the white pine in Maine a close watch has been kept over the pine by people throughout the State, which has resulted in their becoming interested in many insects of the white pine heretofore attracting but little attention.

Conspicuous among such insects during the early summer of 1909 was a dark reddish-brown plant louse, "The Pine-leaf Chermes" shown in Fig. 43 in its characteristic position on the pine needles where it settles to lay its eggs. This Chermes appears upon the pine needle about the middle of June, and some years in conspicuous numbers.

The past summer (1909) hardly a pine in the vicinity of Orono could be found that was not abundantly infested with these winged forms and that the same was true in other parts of the State was shown by specimens submitted to the Station. One such report from Gilead June 25, accompanying specimens, read "Millions of the flies on white pine."

The eggs of this species are not expelled from the bodies of the females. The insects attach themselves firmly to the pine needles with their heads toward the base of the needle and die there with the eggs held in the abdomen which is like a little sac protected by the wing of the parent *Chermes*. Such a cluster contains about 100 eggs. These hatch in 8 or 10 days from the time the Chermes appear on the needle of the pine. The young settle about the new growth of the shoot and piercing the tender tissue with their beaks, suck the sap. Where the infestation is heavy this causes a yellowish and sickly appearance of the new growth which is sometimes thus considerably stunted. The young, though exceedingly minute, can be located because they produce a white flocculent waxy secretion which makes their presence discernable.*

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* Papers from the Maine Agricultural Experiment Station; Entomology No. 37.

The Pine-leaf Chermes is one of those species of plant lice that have alternate "host plants," that is, they pass one stage of their life on one plant and the succeeding stage on another species of plant.

The winged Chermes that appear suddenly upon the needles of the pine in mid-June have not developed on the white pine but in a cone-like gall common on the Red Spruce and Black Spruce, see Fig. 44. This gall is an abnormally developed shoot, the unusual form of growth being stimulated in some way by the presence of the Chermes. The young Chermes can be found in these galls by opening the sections of the galls where little reddish brown objects will be seen,—the developing Chermes.

These galls though sometimes very abundant in Maine are likely to escape notice as they are so cone-like in appearance as to seem to the superficial glance a normal part of the spruce. They were observed by Packard as common in Maine and the plant louse forming them was named *abieticolens* in 1879, the fact that they were the same species Fitch recorded for the pine needle not being known at that time.†

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* Another much smaller species of plant louse (*Chermes pinicorticis*) is frequently present on the trunk of the same tree in such numbers as sometimes to cover almost the entire trunk with a white down.

† This species develops in a cone-like gall on the black and red spruces (in which connection it was named *abieticolens* in 1879 by Thomas and subsequently merged by error with *abietis* in 1897), and migrates to the needles of the white pine (in which connection it had been previously named *pinifoliae* by Fitch in 1858, and merged by error with *pinicorticis* in 1869). This historical discussion with full reasons for resurrecting this doubly merged species under the original name of *pinifoliae,* which has been discarded for about 40 years, will be published presently in more technical form by the Maine Agricultural Experiment Station. For the purposes of this economic bulletin it is not necessary to include either detailed descriptions or discussion.

The full grown Chermes acquire wings about the middle of June when they leave the spruce galls and seek the white pine.

Remedial Measures. There would seem to be no practical method of combatting this insect in forest growth. With ornamental trees, however, the galls could be removed from the spruce previous to the emerging of the winged form. Also if the species proves constantly troublesome it might be desirable not to plant the white pine in the vicinity of black or red spruce and *vice versa.*

Spraying with whale-oil soap (1 pound to 2 gallons of water) would doubtless destroy the young on the white pine shoots, but it is doubtful that this would be usually worth while in Maine where Syrphus flies abound. The larvæ of these, little light colored maggots, have been found to feed industriously on the young Chermes. So numerous are these beneficial maggots at times in the midst of the white waxy secretion of the Chermes that they are sometimes mistaken by people submitting them for determination as the cause of the trouble.

THE GREEN-WINGED CHERMES (*Chermes abietis* Linn).

An entirely different sort of gall common in Maine on the White Spruce, and Norway Spruce, is caused by another species of Chermes which is here termed the "Green-winged Chermes" as the conspicuous and constant green tinge of the wings is a character which will readily serve to distinguish it from the "Pine-leaf Chermes" by those who would find a more technical comparison troublesome.

Fig. 45 shows 3 of these galls together with 6 cones, about natural size on a white spruce twig. It will be seen that these galls differ from those shown in Fig. 44 in not being cone-like and in not being characteristically terminal on the shoot. These *abietis* galls do not usually cause the death of the shoot on which they grow but they do cause deformed branches and frequently ruin a small tree for ornamental purposes. Such galls are very abundant on the Norway spruces on the University of Maine Campus. That they are troublesome on native spruce in this locality is shown by the fact that on a single white spruce 3 feet tall more than 990 of this season's galls were counted August 1, 1909. Where so numerous, these galls are much smaller than those shown in Fig. 45.

These galls begin to open about August 15 in Maine. The full grown pupæ walk out on the spruce needles, where they molt their pupal skins. The newly emerged winged insect is yellowish with distinctly green wings and even the wings of the aged specimens retain the green color.

Unlike the Pine-leaf Chermes, this Green-winged Chermes does not use alternate host plants. That is, it does not seek the pine or any different kind of tree to lay eggs on than that on which it produces the galls. Shortly after emerging from the gall it lays its eggs on the spruce and the young which hatch from them do not acquire wings but develop to a wingless form living solitary over winter on the twig. This is the form that lays eggs in the spring for the generation that causes the development of the gall which shelters them.

Remedial Measures. Spraying the trees in April with whale-oil soap solution (1 pound to 2 gallons of water) has been reported as effectual. (34th Report Mass. Agric. College). The practice of removing and burning the galls will serve to control this species sufficiently on ornamental trees. At Orono great numbers of the winged forms are caught in spiders' webs that are spun irregularly over the spruce twigs.

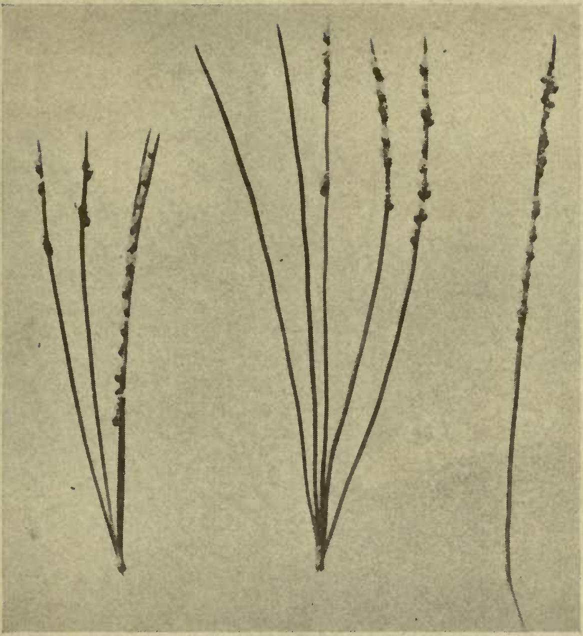

FIG. 43.—The Pine-Leaf Chermes. Migrants from the spruce-gall to the white pine.

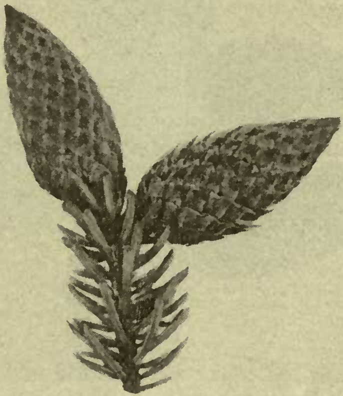

FIG. 44—Black spruce twig with two cone-like galls caused by the Pine-Leaf Chermes.

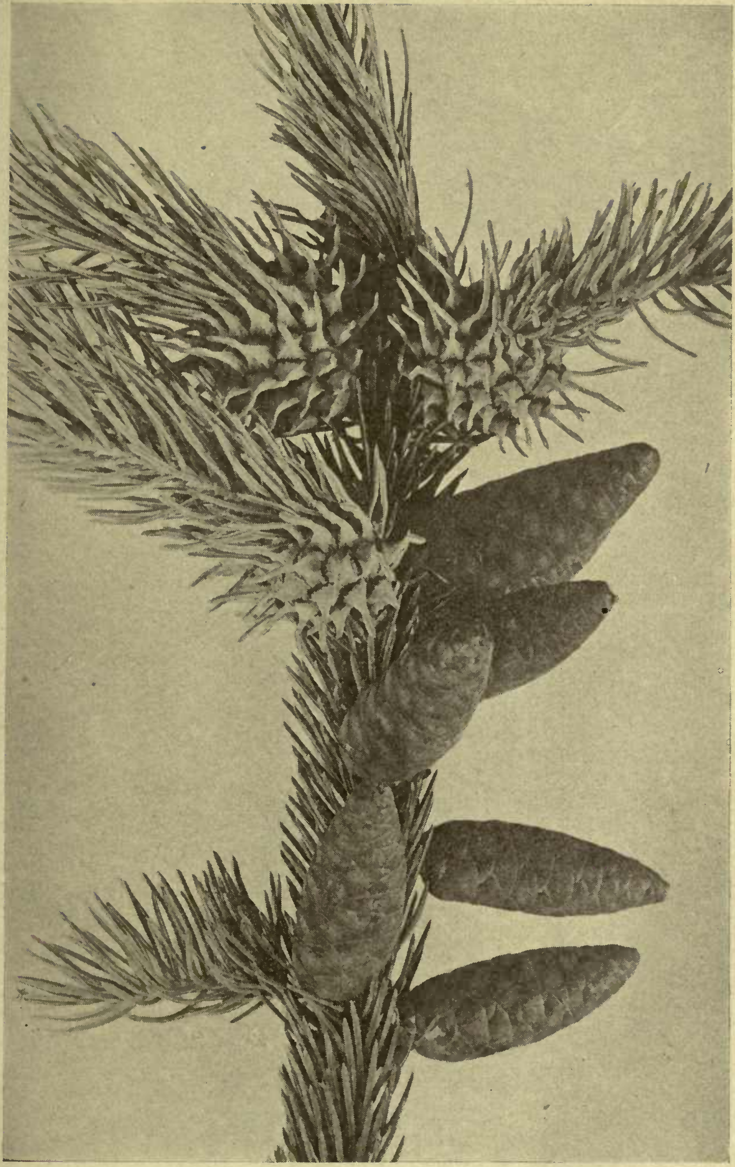

FIG. 45—Twig of white spruce with three "pine-apple galls" of *Chermes abietis* and six normal cones.

BULLETIN 170.

Bulletin 170 discussed from the technical standpoint two species of fungi that have, for the past two years, been under experimental observation by the plant pathologists in relation to apple diseases. The practical bearing of these fungi upon orcharding will be discussed in a bulletin to be issued early in 1910. For these reasons this bulletin (170) was printed in a limited edition and was sent only to the official mailing list, to libraries and to exchanges. Copies may be had on application to the Station.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 173. DECEMBER, 1909.

CHERMES OF MAINE CONIFERS.

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ORONO, MAINE.

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BULLETIN No. 173.

CHERMES OF MAINE CONIFERS*

BY EDITH M. PATCH.

THE PINE LEAF CHERMES.

Chermes pinifoliae Fitch.

Chermes abieticolens Thos.

It is manifestly a pleasure to reinstate a species lost in a list of synonyms and an unusually interesting situation is found in the present study which justifies removing a species merged by error with two widely different Chermes† one on pine and one on spruce, and uniting these two forms in turn under the name of the form first described.

The species under consideration develops in a cone-like gall on the black spruce and migrates to the needles of the white pine to oviposite and was named, as commonly happens with aphids with two distinct host plants, separately in each situation.

The evidence concerning each will be taken in turn. Fitch's description of *Chermes pinifoliae*,‡ (though without figures or much structural detail) is excellent in that it selects several distinctly characteristic phases of this species and is sufficient to distinguish it from any of the other *Chermes* recorded in this paper.

Fitch's published account of the species is here given in full:

"267. Pine-Leaf Chermes, *Chermes Pinifoliae*, new species.

"Stationary upon the leaves, usually towards their ends, puncturing them and sucking their juices, a very small black fly 0.08** long to the tip of its abdomen, and 0.12 to the end of its wings, which are dusky gray, its abdomen dusky red and slightly covered with fine cottony down.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 39.

† *Chermes pinicorticis* and *Chermes abietis*.

‡ Trans. N. Y. Agric. Soc. 17: 741; id. Rept. Ins. N. Y. 4: 55, 1858.

** Fitch's measurements are given in decimals of inches.

"The females of these insects do not extrude their eggs. Clinging closely to the leaf with their heads towards its base, they die, their distended abdomens appearing like a little bag filled with eggs. The outer skin of the abdomen soon perishes and disappears, leaving the mass of eggs adhering to the side of the leaf, but completely covered over and protected by the closed wings of the dead fly. I have met with the dead females thus adhering to the leaves the first of July, and have noticed the same insects on the leaves in full life and vigor the middle of May.

"The rib vein of the fore wings runs straight to the outer margin forward of the tip, and gives off from its middle on the outer side a very oblique branch which runs to the outer margin, its tip producing a slight angular projection to the edge of the wing, and the whole space on the outer side of the rib vein beyond this branch is more opake than the rest of the wing and of a smoky yellowish color. From its inner side the rib vein sends off three simple oblique veins, the last one of which ends in the extreme tip of the wing. The hind wings have an angular point on their outer side beyond the middle, and a longitudinal rib vein, which, forward of its middle sends off a branch almost transversely inward, its tip curved backward. The antennae are short, thread-like, and composed of four or five small joints. It will hence be seen that this insect is a true Chermes—the first species of this genus that has been discovered in this country."

The fact that a *Chermes* described by Fitch as 0.08 inches long to the end of the abdomen (0.12 inches long to the tip of the wings) and the accurate and characteristic account of the place and manner of ovipositing on the pine needles could have been considered the same as *Chermes pinicorticis** for the past 40 years, is sufficient proof that none of the observers who have worked with *pinicorticis* have been familiar with Fitch's other species, i. e., *pinifoliae*.

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* 1869, Shimer. Trans. Am. Ent. Soc. II, 383.
1884, Osborn. Bull. A. E. S. Ia. No. 2, 97-105.
1898, Storment, Rept. Ent. Ill. 20 iii-xxiii, pl. i-ii.

Thomas in his third report makes the following statement[†] concerning *abieticolens.*

"CHERMES (ABIETICOLENS?)

"Adeleges of the Spruce. Packard.

"A rather large species mentioned by Dr. Packard as 'found in abundance on the spruce in Maine, where it produces swellings at the ends of the twigs, resembling in size and form the cones of the same tree.' The specific name is applied provisionally and only for use in this report. This is certainly distinct from the European species *Chermes abietis* Linn., which is much smaller, of a bright reddish-brown color, with the wings tinged with green."

Packard[‡] reports this species as follows:

"37. The Spruce Bud-louse, *Adelges abieticolens*, Thomas.

"Deforming the terminal shoots of the spruce, producing large swellings, which would be readily mistaken for the cones of the same tree.

"We take the following account and illustration from our Guide to the Study of Insects:

" 'The genus *Adelges* was proposed by Vallot for certain broad, flattened plant-lice which attack coniferous trees, often raising swellings on twigs like pine and spruce cones. The antennae are short, 5-jointed and slender; there are three straight veinlets arising from the main subcostal vein and directed outwards, and there are no honey tubes; otherwise these insects closely resemble the Aphides. A species closely related to the European *Adelges* (*Chermes*) *coccineus* of Ratzeburg, and the *A. strobilobius* of Kaltenbach, which have similar habits, we have found in abundance on the spruce in Maine, where it produces swellings at the ends of the twigs resembling in size and form the cones of the same tree. We would add that each leaf-bud is enlarged, having an *Adelges* under it. As those nearest the base mature first and leave their domicile, the deformed leaf-bud stands out from the axis of the shoot, thus giving the conelike appearance to the end of the shoot.'

"This has since been described by Prof. Cyrus Thomas in his Third Report on the Injurious Insects of Illinois, p. 156."

[†] Rept. Ent. Ill. 8: 156, 1879.

[‡] Insects Injurious to Forest and Shade Trees.

That Packard himself was familiar with the galls of both *abieticolens* and the European *abietis* and considered them distinct is shown by his item which follows the foregoing one just quoted:

"38. The European Spruce Bud-louse, *Adelges abietis* Linn.

"We observed this species in considerable numbers on the Norway spruces on the grounds of the Peabody Academy of Science at Salem, in August, 1881. The deformation produced in the terminal buds and twigs were like those figured in Ratzeburg's Die Waldverderbniss, Bd. i, Pl. 28, figs. 1, 2."

Thomas states that he was certain that he was dealing with a distinct species, and one brief item is sufficient to prove him correct, for he uses one difference which is alone enough to separate these two species when he says that with the European species, *Chermes abietis* Linn. "the wings are tinged with green". While color distinctions are often an unsafe basis, it is steadfast one here, for *Chermes abietis* has uniformly and conspicuously green wings while the dark species developing in that Spruce gall ("found in abundance on the spruce in Maine") which when deserted "stands out from the axis of the shoot, thus giving the cone-like appearance to the end of the shoot" has the stigmal region reddish brown, or 'smoky yellowish,' and never at all greenish either when newly emerged from the gall or upon aging.

It seemed desirable in a circumstance so complicated to give, before presenting original data, the historical situation for the species under consideration, which develops in a cone-like gall on the black spruce (in which connection it was named *abieticolens* in 1879 by Thomas and subsequently merged by error with *abietis**), and migrates to the needles of the white pine (in which connection it had been previously named *pinifoliæ* by Fitch, 1858, and merged by error with *pinicorticis*† in 1869 where it has remained for 40 years in oblivion).

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* Fernald and Cooley, 34th Report Mass. Agric. College 1897, pp. 89-100.

† Shimer. Trans. Am. Ent. Soc. 2: 383.

CHERMES PINIFOLIAE IN MAINE.

On June 16, 1905, I first found winged *Chermes* in great abundance on the needles of white pine (*Pinus strobus*) at Orono. My notes for that date state that on some branches nearly every pine needle had a *Chermes* stationed near the tip with the head away from the tip. On some needles were three or four. Most of the specimens observed at this date were dead. A large cluster of eggs was found beneath the wings of each *Chermes*. Eggs brought in June 16 hatched June 26.

Immediate reference to Fitch's description gave such a striking agreement of my notes with his account of the egg laying habit of *Chermes pinifoliae* that I listed the collection under the name of that species. Mounts were made of the freshest specimens a few of which were still alive. These I took with considerable other material to Mr. Pergande the following winter and he kindly compared them with Fitch's type* of *Chermes pinifoliae* and stated that the type specimen was too imperfect to give a satisfactory basis of comparison but that in size and in such points as could be compared the two agreed and that he considered the specimens from Maine to be *pinifoliae*.

July 5, 1907, at Milo, Maine, I observed this species very abundant on the needles of white pine. The specimens were all dead at this date but they still adhered to the needles, on some of which there were as many as 14 or 16 in Indian file with their heads towards the base of the needle. This was in accordance with Fitch's observation "I have met with the dead females thus adhering to the leaves the first of July." Specimens of this collection were photographed as taken. See Fig. 127.

On June 14, 1909, a large number of black spruce twigs were brought to me with the statement that "almost every *cone* is infested under the scales and is abnormal in form." Some of these specimens are shown in Figs. 128 and 129. The infested growths at this stage were indeed so cone like that I took their cone-ship for granted until I read over Packard's discussion of *abieticolens* Thomas which he "found in abundance on the spruce in Maine, where it produces swellings at the ends of the twigs resembling in size and form the cones of the same tree." Dissection of the galls, of course, proved they were not abnormal *cones* but abnormal *shoots*.

---

* Fitch's aphid types were originally mounted on card points on pins. A few of these came finally to the U. S. collection where they were removed and are preserved as balsam mounts.

The mistaken identity of the so-called "cones" seemed a good joke entomologically and as the collector of the galls is a plant morphologist perhaps not less so botanically.

Both the galls and the *Chermes* in them are distinct from *abietis* and there seems no ground for doubting that this species is *abieticolens*.

Some of the more advanced galls of *Chermes abieticolens* were opening on date of collection, June 14, and by June 21 fresh *Chermes pinifoliae* were on the needles of White Pine everywhere in the neighborhood of Orono. Others were sent in from other parts of the state a little later. Accompanying such specimens from Gilead vicinity on June 25 "millions of the flies on white pines" were reported.

As the disappearance of the emerging *abieticolens* from the spruce coincided exactly in time with the appearance of *pinifoliae* on the white pine and as there was no apparent difference in the *Chermes* in these two situations the conclusion was obvious enough and careful microscopic comparison was, of course, made. There was no difference between the two discoverable in any structure submitted to this sort of examination. The freshest of the specimens on the white pine had of course to be used for the comparison.

A check migration test was made June 22. A lot of galls from the black spruce were placed in a cage with fresh twigs of various conifers. On June 25, more than 200 individuals had settled on the white pine where they remained with their eggs. Although specimens were found crawling over some of the spruce twigs supplied them no individual settled and oviposited except on the white pine. This was more overwhelming preference than is usual with a cage test, for often in confinement a few stray specimens oviposite amiss, as it happens also to insects in the open. Perhaps if the test had been prolonged some of these would, but three days with the uniform result of 200 to 0 seemed sufficient.

In confinement, as in the open, these *Chermes* settled on the pine needles with the head toward the base of the needle. Out of the thousands seen this season only very rarely was one found headed in the other direction. In confinement as in the open this species did not "oviposite" in the usual sense of the term, as the eggs were not expelled. As Fitch himself accurately recorded what I have observed three seasons (1905, 1907, 1909*) "the females of these insects do not extrude their eggs. Clinging closely to the leaf with their heads towards its base, they die, their distended abdomens appearing like a little bag filled with eggs. The outer skin of the abdomen soon perishes and disappears, leaving the mass of eggs adhering to the side of the leaf, but completely covered over and protected by the closed wings of the dead fly." Such an egg cluster comprises about 100 eggs.

The eggs of the *Chermes* which settled on the pine needles June 22-25, in the cage migration test recorded, were hatching July 3, in conspicuous numbers.

These young, the progeny of the migrants, settle at the tips of the new pine shoots where by the latter part of July their presence is rendered conspicuous on account of the white waxy secretion of the *Chermes*. This secretion gives a white woolly appearance to the infested portion similar to but much less dense than that of *pinicorticis* on the trunk of the white pine.

Where the infestation is heavy it causes a yellowish and sickly appearance of the new growth which is thus considerably stunted. As will be seen by Fig. 132 taken July 23, 1909, the new needles are not at this time full grown. The new needles on twig photographed were yellowish for a part of their length and the whole tip of the twig had an unhealthy appearance.

It will be seen from the date of the flight of this species from the spruce galls to the pine, about June 15-21, that the pine leaves on which they settle to oviposite are those of previous years growth, that is, the needles of 1909 have not started sufficiently for the *pinifoliae* of June 1909 to use.

This fact is in contrast with a second species, *Chermes floccus*, migrating from black spruce galls to pine needles late in July and ovipositing both on old growth and new growth needles. There is no reason for confusing *pinifoliae* with this second species as the discussion of the latter will make plain.

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* I am not able at present to state whether there may be any significance in this once in two years collection or not. I had not been paying any particular attention to *Chermes* and they may have been present in considerable numbers the other years also, and I had merely neither collected nor recorded them. The notes as they stand suggest a two year cycle but no observations as regard to this are yet available.

On May 19, 1908, I found *Chermes* pupae common on terminal shoots of white pine. My notes for this collection read: "The pupae are massed close to the tip of the stem or at the base of needle cluster on some stems, and on others they occur singly at the same locations. They are downy enough to be noticed but are not very flocculent."

I collected a considerable number of twigs and the next day many of the pupae molted and an abundance of winged adults were secured. These I listed at the time as *pinifoliae*, and on going carefully over this preserved material this fall I can see no reason to separate it from the species which matures in the black spruce gall about the middle of June. Antennal, wing, and leg characters are apparently identical and the gland areas are so faintly indicated as to ally it with this species and separate it from any other taken in Maine.

These mid-May *Chermes pinifoliae* are, I believe, the return migrants from pine to spruce, but I have not observed this migration. They are not the generation that oviposites on the pine needles, however, as this is done by the migrants from the spruce. This collection, May 19, it will be seen, is in accordance with Fitch's statement that he had "noticed the same insects on the leaves in full life and vigor the middle of May."

It will be seen from the dates of the migrants that either the time which *pinifoliae* spends on the spruce is very short—four to six weeks—or that a two year cycle is required. It is not at present possible to say which is the case.

The galls are uniform, regular, and cone-shaped in form. In length they vary when full grown from about three-fourths to one and one-half inches. Under the stimulation of the *Chermes* the new growth at the tip of the twig is modified and the twig tip develops into a cone-shaped object. The stem itself is not much swollen. Each needle becomes a scale, broadest at the middle and concave on the inner surface. Beneath each scale-like leaf a single Chermes develops. Packard states that in the gall of *abieticolens* "each leaf bud is enlarged having an *Adelges* under it" which statement in itself would distinguish such a gall from that of *abietis* each cell of which contains not "*an*" but *many* individuals. A single gall of *pinifoliae* not under average size which I dissected was found to be composed of 139 scale-like leaves under each of which was a single pupa.

The gall when young is slender, about the same length as the young cone and often about the same purple color. Fig. 129 shows a black spruce twig with a single young cone at *A*, the tip of which is unfortunately broken; at *B* are four normal spruce tips; at *C* are four young galls of *pinifoliae*. This photograph shows very well the distinguishing feature of these three growths, the normal shoot, the modified shoot or *Chermes* gall, and the normal cone.

Fig. 128 shows a fully developed gall which at this stage is green. After the galls lose their first purple color they remain green until the time of the emergence of the migrants. Fig. 130 shows the normal cone at *A* which at this stage is purple, at *B* the normal shoot which is green, at *C* the deserted gall which is bright reddish brown. After the gall is deserted the gall leaves flare out from the stem, leaving the chambers open wide. About this time the gall becomes a bright reddish brown, that is the galled terminal shoot dies in this characteristic way.

Pupa. The full grown pupa (June 14) is dark reddish brown with thorax somewhat lighter than head and abdomen. Legs and antennae dusky. Body lightly threaded with short wax fibers, giving body a downy appearance.

Winged Female. Fig. 108. The newly molted migrant, before the wings are expanded, is glistening reddish brown with pellucid legs and antennae. The crumpled wings are distinctly yellow. The wings when expanded are smoky, the stigmal region is yellowish or reddish brown. The migrant by the time it has reached the pine needles is very dark, with "its abdomen dusky red and slightly covered with fine cottony down." The antennae and legs are dark. In size these migrants vary greatly as indeed do all the *Chermes* listed in this paper. The total length of body of this form ranged from 1.7 mm. to 2.9 mm. (.066 in. to .11 in.) the latter measurement being for the larger individuals with their abdomens fully extended. The wing expanse varies also, the average being about 8 mm. There is nothing especially striking in regard to the venation. The characteristic curves of the veins have been faithfully reproduced (Fig. 108). At the junction of *Sc* with costal margin the wing creases a little and a decided angle occurs at that point in the wings of this species except when they are newly emerged. This angle is more pronounced for this species than any other of these Maine species, though the same tendency is often shown by others to a slighter degree. The drawing was made from a wing of a newly emerged individual and this costal angle not indicated.

The most distinctive characteristic in the wings of *pinifoliae* is the decided arch of the costal margin of the fore wing and the almost circular curve of the hind margin of the hind wing. The shape of the wings alone would separate this species from the other five developing in spruce galls in Maine. Packard's figure of *abieticolens** gives the characteristic outline of this peculiar wing which alone would serve to separate it from *abietis*. The legs are very stout.

The antennae (Fig. 109) are 5-jointed, the segments stout, III, IV and V are approximately subequal in length. III and IV resemble each other closely both as to shape and sensorial areas. V has the curve of the outline less abrupt, and the sensorial area larger. Terminal hairs four or five in number and slender (Fig. 109a). The sensorial areas as well as the shape of segments and reticulations are shown in the figure of antenna more distinctly than verbal details could indicate.

The wax pores of this species are more difficult to find than on any of the other species recorded in this paper. Even in specimens fairly well cleared the gland areas were not always evident. However, from a large series of mounts of specimens cut transversely giving the clearing fluids every opportunity, the gland areas (Fig. 108) were found to be consistently as follows: head with an area of two transverse groups on anterior margin nearly coalescing, an area of two transverse groups at posterior margin; prothorax with an irregular lateral area, a median anterior area of two groups, and a row of 4 groups near posterior margin; mesothorax with a lateral group on anterior margin and a median area of two groups on posterior portion

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* Insects Injurious to Forest and Shade Trees.

of the lobes; metathorax with a median area of two groups corresponding to the median rows of the abdomen; abdomen with median area in two groups (or frequently merging) on segments 1-7, and a lateral group on segments 1-9 (merged on the ninth). In addition to these there occurs between the lateral and median groups on segments 1-4 a very small group of two or three pores usually separate from the median pores, but sometimes merged with them. Most, if not all, of these wax pores would easily be overlooked and the fact that this species has its abdomen only "slightly covered with fine cottony down" indicates that the glands are not so functionally active as those of other species.

Remedial Measures. There would seem to be no practical method of combatting this insect in forest growth. With ornamental trees, however, the galls could be removed from the black spruce previous to the emerging of the winged form. Also if the species proves constantly troublesome it might be desirable not to plant the white pine in the vicinity of black spruce and *vice versa.*

Spraying with whale-oil soap (1 pound to 2 gallons of water), would probably destroy the young on the white pine shoots, but it is doubtful that this would be usually worth while in Maine where Syrphus flies abound. The larvae of these, little light colored maggots, have been found to feed industriously on the young Chermes. So numerous are these beneficial maggots at times in the midst of the white waxy secretion of the Chermes that they are sometimes mistaken by people submitting them for determination as the cause of the trouble.

Note: The foregoing evidence will make it clear enough that Shimer was in error in considering the winged specimens which he reared from *pinicorticis* to be *pinifoliæ.* That Shimer found winged *pinicorticis* "very plentifully" on the pine leaves would be natural enough for at the time of emergence the winged forms are sometimes abundant on all parts of the tree. I have seen them in considerable numbers resting on pine needles apparently just before flight, but never fixed as described by Fitch as characteristic of *pinifoliæ.* Observers of *pinicorticis* have accepted Shimer's conclusions that his *Chermes* .025 inches long which he bred from pupal *pinicorticis* was the same as *pinifoliæ* described as .08 inches long, in spite of the fact that they have had to contradict Fitch's explicit observations in regard to the very characteristic habits of *pinifoliæ.* With the meagre descriptions of the early aphid records many such mistakes are scarcely avoidable, in absence of the species itself. Fitch's comments on *pinifoliæ,* however, are distinctive enough so that with his species in hand it no longer seems "singular" and "unfortunate" that he described *pinifoliæ* as distinct from *pinicorticis,* but rather singularly interesting that this species had not been rediscovered long ago.

To see that Fitch's much discussed description of the wing of *pinifoliæ* agrees with fig. 108 it is only necessary to translate it to modern parlance "The rib vein (Rs) runs straight to the outer margin forward (proximad) of the tip, it gives off from its middle on the outer side a very oblique branch (Sc) which runs to the outer (costal) margin, its tip producing a slight angular projection* to the edge of the wing, and the whole space (stigma) on the outer side of the rib vein (Rs) beyond this branch (Sc) is more opake than the rest of the wing and of a smoky yellowish color. From its inner side the rib vein (Rs) sends off three simple oblique veins, the last one (M) of which ends in the extreme tip of the wing. The hind wings have an angular point (for hooks) on their outer side (costal) beyond the middle, and a longitudinal rib-vein (Rs) which forward (proximad) of its middle sends off a branch (M) almost transversely inward (caudad) with its tip curved backward (distad)."

1858. *Chermes pinifoliae* Fitch. *Trans. N. Y. St. Agr. Soc.* for 1857, *Vol.* 17, 1858, *p.* 741. Republished in 4*th Rep. Ins. of N. Y.* 1859 *p.* 55.
Description of winged form.

1862. B. D. Walsh. *On the Genera of Aphididae Found in the U. S.* Species listed only.

1869. Henry Shimer. *Trans. Am. Ent. Soc., Vol.* 2, *p.* 384. Winged forms of *pinicorticis* mistaken for *pinifoliae.*

1879. Cyrus Thomas. *Eighth Rep. St. Ent. of Ill., p.* 156. Quotes Fitch's description.

1881. A. S. Packard. *Insects Injurious to Forest and Shade Trees. p.* 118. From Fitch.

1884. Herbert Osborn. *Bulletin No.* 2. *Iowa St. Agr. Coll. Dept. of Ent.* Follows Shimer's error in considering winged *pinicorticis* to be *pinifoliae.*

1885. J. A. Lintner. *2nd Rep. St. Ent. of N. Y., p.* 180-187. Follows Shimer's error in considering winged *pinicorticis* to be *pinifoliae.*

1890. A. S. Packard. *Fifth Rept. U. S. Ent. Comm. p.* 805. Fitch's description quoted, without comment.

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* See page 286 for comment.

1898. Storment. *Rept. Ent. Ill.* 20; iii-xxiii. Follows Shimer's error in considering winged *pinicorticis* to be *pinifoliae.*

1901. W. D. Hunter. *Iowa Agric. Coll. Exp. Sta. Bull.* 60. *The Aphididae of North America.* Lists *pinifoliae* as a synonym of *pinicorticis.*

1909. Edith M. Patch. *Annals of the Ent. Soc. of Am. Vol. II. No.* 2. Discussion of tracheation of wings of *Chermes pinifoliae.* Pp. 107, 111, 116 and figs. 26-30.

1909. Edith M. Patch. *Me. Agric. Exp. Sta. Bul. No.* 171. Economic treatment giving main features of life history of *pinifoliae* and stating that *abieticolens* is the gall generation of the same species.

1909. Edith M. Patch. Psyche Dec. 1909, pp. 136-137.

Chermes abieticolens.

1869. A. S. Packard. *Guide to the Study of Insects, p.* 522. Brief description with figures of this species recorded as a species of *Adelges* occurring in abundance on the spruce in Maine. Some good characters of gall also given.

1879. Thomas. *Rept. Ent. Ill.* 8: (*III of Thomas*) *p.* 156. Species named provisionally as *Chermes abieticolens* and statement made that it is certainly distinct from *abietis.* Refers to Packard.

1885. J. A. Lintner. *2nd Rep. St. Ent. of N. Y., p.* 185. Refers to Packard and Thomas.

1887. Oestlund. *Aph. Minn.* Species listed.

1890. A. S. Packard. *Fifth Rep. U. S. Ent. Comm. Adelges abieticolens* Thomas. Original account and illustration copied.

1897. Fernald and Cooley. 34*th Report Mass. Agric. College, pp.* 89-100. *abieticolens* merged with *abietis* by error on the basis that in response to "about five hundred circular letters sent to different persons in the U. S. and Canada, only one species of *Chermes* was received." Excellent account of *abietis.*

CHERMES ABIETIS Chol.

This common European species has been variously designated as "The Spruce Gall-louse"*, "The European Spruce Bud-louse"†, "The Yellow Chermes"‡, "The green-winged Chermes"** and the gall has been aptly called the "pine-apple gall" on account of its form.

This species has been for a good many years annually abundant on the Norway and white spruces on the campus of the University of Maine. I have collected the gall and the insect at various stages frequently since the fall of 1903, without giving the species any especial study except to compare my own observations with published accounts.

Confusion in the literature of this species both in this country and in Europe has existed on account of other species having been confounded with it. Because of this it may not be out of place to present my own notes, though probably containing no new observations, in connection with the photographs of the galls and the drawings of the species which they concern.

The Gall. Fig. 137. The galls of *abietis* vary in size from about ½ inch to 1 inch or more in length. They occur at the base of terminal shoots and do not as a rule kill the twig. Where they are numerous they cause serious deformations of the branches, and small trees are sometimes ruined by their presence. Such galls are not only very abundant on Norway spruces but they are troublesome on the native white spruce in Maine. This season (1909) a single white spruce 3 feet tall had more than 990 fresh galls upon it. The growing galls are green, with the closed mouths of the cell marked by a ʌ-shaped red line. The shade of this line varies from purple to brick red in different galls and at different times. The galls resemble in form a little pine-apple, each section being represented by a needle much enlarged at the base and little if at all at the tip. The relation of the galls to the twig on which they grow is shown in the longitudinal sections in Figs. 138 and 139. It will be seen that in some cases the gall entirely encircles the twig which continues its growth from the apex of the gall, while in others the gall is produced in a one sided manner only partly encircling the twig. The cells of the gall are closed. A sample gall about ¾ inches long contained about 50 cells each holding from 8 to 12 nymphs. This count was made August 13.

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* 34th Report Mass. Agric. College.

† Packard, 5th Report of Ent. Comm. page 853.

‡ Die Coniferen-Läuse Chermes. Prof. N. Cholodkovsky. 1907.

** Me. Agric. Exp. Sta. Bul. 171.

About the middle of August at Orono the mouths of the cells open and the pupae emerge to molt.

Nymphs, the Gall Generation. Specimens taken from galls June 23, 1904, are recorded as greenish yellow. July 24, 1909, nymphs are recorded as very pale yellow covered with white pulverulency. Molted skins attached to caudal extremity were filled with liquid so as to retain their shape. Many nymphs had two such molts attached so that three successive stages of the insect were in line. The excreted liquid being largely disposed of in this manner, the cell wall of *abietis* is clean and dry, a condition made further possible by a slight covering of waxy powder.

Pupae. Body length of full-grown pupa 1.9 mm. Specimens taken from galls on Norway spruce August 4, 1909, were very pale yellow, slightly pulverulent. Others taken from galls on white spruce August 17, 1909, were a little darker yellow and the finely-pulverulent abdomen had a slight rosy tint. The pupae leave the galls before molting. The time of most plentiful emergence is from about the middle to the last of August for the vicinity of Orono, though the galls in more exposed sunny places are about a week earlier in opening than the average shaded ones. The pupae creep from the open cells of the galls in a sluggish manner and often rest in Indian files on the needles near the gall, where they molt and become the winged individuals. The cast skins remain in white rows upon the needles for some time unless dislodged by rain. See Fig. 140.

The wax pores for the pupa are: (Fig. 117) head with an anterior group of pores near base of each antenna and two median groups at posterior margin; prothorax with lateral gland area, an anterior median pair of groups, a small group (4 pores) between the lateral and median ones, and four groups near posterior margin of prothorax; mesothorax with an anterior lateral area; metathorax with two separated median groups; abdomen with small and widely separated median groups on segments I-VI, those on I being composed of about 6 pores, those on II of 3 and those of III-VI of 2 each, a very small group of lateral pores occur on segments II-IX (merged to a caudal group on IX), and about half way between the median group and lateral margin an additional group of about 3 pores occurs on segments I and II. The smallness of these inconspicuous groups is correlated aptly with the fact that this is not a flocculent species, the wax secretions not exceeding the pulverulent condition. Fig. 117 shows a pupa a short time before the final molt.

Winged Oviparous Form. Fig. 115. The freshly molted individuals, August 19, 1909, have a golden brown body, the thorax, except the dorsal lobes, slightly lighter than abdomen, lobes of thorax dark, head dark, wings with whole stigmal area and margin a decided and conspicuous green, the remainder of the wing being white with a slight yellowish green tint. As the individual ages the coloring becomes darker, though the wings retain their characteristic green color. Length of body 1.7 to 2 mm., wing expanse 6.mm.

The areas of the wax pores (Fig. 115) are much as in the pupa except for the abdomen which is as follows: I with median groups comparatively large and merged, II median groups separated and composed of 2 pores each, V with two small groups between median ones referred to. I-VIII with distinct lateral groups on darkened area, III-VI with small groups of 2 or 3 pores each midway between median and lateral groups.

The wing veins of this species have, as with the other five discussed in this paper, a fairly constant characteristic trend which is shown in Fig. 115. First A of the fore wing is seen to be considerably arched.

The sensorium of each of antennal joints III-V is confined to the distal half of the joint and extends not more than half way around the joint. These three joints are much alike in general appearance. III is noticeably shorter than IV while IV and V are subequal. The usual group of smaller sensoria occurs on V and there is nothing striking about the 4 or 5 terminal hairs. Fig. 116.

Apterous oviparous form—winter female or stem mother. May 7, 1906, I observed these young females of the winter generation, minute and slightly downy clinging close to the buds or in the axle of the leaves on Norway spruce. May 31, 1906, the females were very plentiful and were readily detected on account of the little white flocculent mass surrounding her and her recently laid eggs. One such egg cluster contained about 140 eggs and the female was not through ovipositing.

The life cycle for *abietis* based upon the writer's observations is briefly as follows: Galls open about mid-August and fully grown pupae emerge and molt within a few hours becoming the winged form which deposits a cluster of 40 to 50 yellow eggs on a spruce needle. The eggs are extruded from the abdomen but the parent *Chermes* remains over them until dislodged after her death by wind or rain. The winged form often oviposites near the gall from which it emerges. A different species of host plant is never sought by this *Chermes*. In about two weeks the young "stem mothers" hatch from these eggs and seek a protecting crevice in the surface of the spruce bud where they can spend the winter. These wingless forms develop in the spring and become full grown about the last of May when they lay a cluster of 140 or more eggs. From these eggs hatch the young that inhabit the gall and are known as the "gall generation" with which we started the cycle.

For a further account of *abietis* the reader is referred to the 34*th Report of the Mass. Agric. College*, 1897, and to *Die Coniferen-Läuse Chermes* by Prof. N. Cholodkovsky, 1907.

Remedial Measures. Spraying the trees in April with whale-oil soap solution (1 pound to 2 gallons of water) has been reported as effectual. (34th Report Mass. Agric. College). The practice of removing and burning the galls will serve to control this species sufficiently on ornamental trees. At Orono great numbers of the winged forms are caught in spiders webs that are spun irregularly over the spruce twigs.

Bibliography. It does not seem practical to attempt a bibliography of *Chermes abietis* for United States. That various other *Chermes* have been confused with this species is certain, but to what extent it is often impossible, on the basis of the references, to be sure. The illustration in Bulletin 56, West Virginia Agricultural Experiment Station 1899 of the "Galls and deformed twigs of the spruce gall louse" (Fig. XXXI, page 261) does not figure galls of *Chermes abietis* but those of some other *Chermes*, possibly of *similis*.

In the Spruce Gall-louse *Chermes abietis* Linn. by Fernald and Cooley (34th Report Mass. Agric. College, 1897) is presented carefully the life history and habits of this species. The figure of the gall Plate II in that paper is the characteristic *abietis* gall and the wings on the same plate show the typical curves of the veins of this species. The record of *abietis* from Colorado (page 4 of Author's separata p. 92 in 34 Report) however applies to *Chermes cooleyi* (See Gillette *Chermes of Colorado Conifers* page 3), and *abieticolens* of Packard and Thomas is by error in that publication considered to be the same as *abietis*.

CHERMES LARICIATUS Patch.

A gall resembling that of *abietis* very closely in size and form and found, like that of *abietis*, on white spruce was taken in the vicinity of Orono by Mr. William Woods, July 28, 1909. Fig. 141 shows two of these.

The galls. Like the galls of *abietis* they are not terminal on the twig and the tip of the twig extends out from their apex when they encircle it, or along one side of the gall when they do not, just as with *abietis*.

The galls were mature on date of collection. The needles of the gall are green at this season. Conspicuous wide russet lines mark the closed mouths of the galls which gives the gall a general russet color. The needles of the gall are much shorter than is usual with *abietis* on the Norway and White spruces and it is thus a little more pine-apple like in form than *abietis*. Many of the galls were opening at the time they were collected, and the pupæ walk out from the open cells before they molt, as do *abietis*. The galls become dry and brown soon after they are vacated. The cells are not as shallow as those of *abietis*.

The pupa. (Fig. 122). Described from forms just leaving the gall before the last molt. Length of body 2 mm.; head, prothorax and abdomen light reddish; thorax yellowish green; wing pads dark green; ventral prothorax and thorax yellowish green; legs and antennae greenish. The areas of wax pores are well defined; head with anterior area between antennae, and four posterior groups; prothorax with a large lateral area, an anterial row of 4 groups, a posterior area of 2 groups, and a broken line of 4 groups between the anterior and posterior groups; mesothorax with a very large anterior lateral area and a row of 4 groups across the middle of the segment; metathorax with a very large lateral area about the size of that of the mesothorax, and a row of 4 well defined and separated groups which are in line with those of the abdomen; abdomen with lateral groups on I-IX (merged to caudal group on IX), I-VI with a dorsal row of 4 groups on each segment, the median ones being largest but not merged.

The Winged Oviparous Form. Migrant. (Fig. 118). Newly molted individuals have prothorax and abdomen light yellowish brown, head and thoracic lobes dark, legs and antennae greenish, wings decidedly green with yellow proximal portion The individuals, of course, grow darker as they age. Body length about 1.9 mm.; wing expanse 6 mm. to 6.2 mm.

The well defined areas of wax pores are: head with 2 distinct anterior groups and 2 large and separate posterior groups; prothorax with the usual lateral area, a row of 4 anterior groups, and 2 posterior groups widely separated; mesothorax with two median distinct groups; metathorax with two median groups separate and in line with the median groups of the abdomen; abdomen with median groups on segments I-VI well defined and widely separated, well marked lateral groups on segments I-IX (merged to caudal group on IX), and a small group between the lateral and median groups on III-VI.

The antennae (Fig. 119), is more like that of *abietis* than any of the other species of this paper, but the outlines of the joints are less abrupt, the curves of the sensoria are more regular, and V is typically longer than IV. III and IV are about subequal.

The wings resemble those of *abietis* but are distinct enough. 1st A of the fore wing of *lariciatus* is less strongly arched and M of the hind wing is a heavier vein than that of *abietis* and strongly curved with the convexity distad.

July 31, 1909, this species was found to be common on the needles of larch everywhere in the vicinity of Orono. The migrants from the white spruce galls settled on the larch needles and oviposited. The eggs are extruded and not retained in the abdominal cavity as with *pinifoliae*, and the parent is more easily dislodged even than *abietis* and soon drops from the egg mass. There are from 50 to 75 beautiful green (paler than larch green) eggs in a cluster. (Fig. 121). They are slightly pulverulent. The glimpse through a glass at this little *Chermes* with the green eggs showing through her transparent wings is one of the prettiest sights of the insect season. Fig. 120 gives the position of this species when oviposition is nearly finished. The migrants settle on the larch needle either with head toward base of needle or toward tip, apparently indifferently.

On July 31, 1909, opening galls of this species were placed upon sprigs of conifers in cage. The twigs were in vials of water so that they remained fresh. On August 3 the individuals that oviposited were counted with the following results:

Picea rubra Dietr	Red spruce	0
Picea mariana (Mill.) B. S. P	Black spruce	0
Picea abies (L.) Karst	Norway spruce	1
Picea canadensis (Mill.) B. S. P.	White spruce	4
Pinus strobus L	White pine	0
Pinus sylvestris	Scotch pine	0
Thuya occidentalis L.	Arbor Vitae	0
Abies balsamea (L.) Mill.	Balsam fir	4
Larix laricina (Du Roi) Koch	Larch	69

The preference for larch speaks for itself. Whether the other ovipositions have any significance or are merely accidental it is, on the basis of this one test, impossible to say.

Whether *lariciatus* may be the same as *laricifoliae* Fitch I have not been able to decide. There is nothing in the brief description of Fitch's to preclude this possibility. Fitch's color description does not agree in all respects with my notes for *lariciatus* but these were made from specimens immediately after molting and would not be the same as an older specimen. The italisized portion of the original description for *laricifoliae* Fitch which is here quoted entire would apply very well to *lariciatus*. "*Solitary and stationary upon the leaves, extracting their juices, small* black shining flies *0.10 (inch) long*, having the abdomen dark green, *the legs obscure whitish, the wings nearly hyaline with pale brown veins and the large stigma-spot upon their outer margin beyond the middle more opake and pale green.* This is closely like the Pine Chermes, No. 267, but *has the wings more clear, and differs also in some of the details of its colors.*"

So far as I can judge some of the records referred to *laricifoliae* in this country really concern *consolidatus* which is certainly not *laricifoliae* Fitch. It is not improbable that *lariciatus* may prove to be the European *viridis* Ratz. as discussed by Professor Cholodkovsky in *Die Coniferen-Läuse,* 1907. The galls of *viridis* Figs. 1 and 8 in that publication very well picture the galls of *lariciatus* and the host plants are identical.

As the specific characters on which I have laid most stress, antennae, wings and wax gland areas of the winged forms, are not given in so much detail in European publications as the structure of the apterous forms, the figures do not emphasize the same points and the only basis for comparison would be determined European material which may perhaps be possible to secure.

CHERMES CONSOLIDATUS Patch.

July 20, 1909, in the vicinity of Orono Mr. William Woods collected from black spruce some pink and green galls resembling those figured by Professor Cholodkovsky in *Die Coniferen-Läuse Chermes* 1907 for *Chermes strobilobius* Kalt. The flesh of the gall on the surface is a delicate pink, the needles of the gall, much stunted, are a delicate green. Some of the galls collected on the same day were pale green instead of pink. The galls (Fig. 145), are about one-half inch long or less and are terminal. The cells of the galls contained dark red nymphs which were flocculent rather than merely pulverulent, and the cell walls were also covered with the flocculent secretion.

Specimens began to emerge from these galls in the laboratory July 30, and galls found out of doors on red spruce were opening about the same time.

Opening galls of this species were placed in a cage on twigs of red spruce, black spruce, white spruce, Norway spruce, arbor vitae, white pine, Scotch pine, hemlock, balsam fir and larch. In a few days a count of ovipositing individuals was made and it was found that they had laid eggs *very sparingly* on each of the four spruces and balsam fir—1 to 5 specimens on each plant. 9 to 12 eggs were deposited in a mass under the wings. Most of the individuals died without ovipositing at all. This test certainly gave no dependable data, nor did I chance upon this species ovipositing out of doors. The galls in this vicinity were not numerous and the species is very small.

I have taken, however, on June 20, 1909, and about the same time previous years small *Chermes* pupae developing at the base of larch cones in flocculent matter. When these molt they prove to be brown bodied with a caudal flocculent tuft and greenish wings. These winged forms I am unable to separate on microscopic comparison from *consolidatus* (Figs. 123 and 124), and think that there is no reason to doubt that they are the same species, and that the larch and spruce are alternate hosts of *consolidatus*.

Whether they prove to be *strobilobius* Kalt. can only be ascertained by comparison with authentic European material which is not at present available.

Pupa. The pupa, described from specimens removed from spruce galls. -(Fig. 125). Body dark red and flocculent, the larger ones 1.2 mm. long. Areas of dorsal wax pores; head with large groups at anterior and posterior margin; prothorax with lateral areas, a row of 4 large anterior and 4 large posterior groups; mesothorax with a curved transverse row of six well defined groups, the outer ones forming the usual anterior-lateral groups, metathorax and abdominal segments I-VI with transverse rows of 6 groups each, VII-IX with only the marginal group. Fig. 125 was drawn from a pupa in its last stage but sometime before it molted. Later the conspicuous circular space about the gland openings is not so discernable.

The Migrant from the Spruce Gall. (Fig. 123). Length .9 mm.-1.3 mm.; wing expanse 3.5 mm.-4.0 mm. The wings of this species are very rotund. The veins in the fore wing are usually like those given in fig. 123 though frequently they are straighter. M in the hind wing usually curves with the concavity distad though sometimes this vein is nearly straight.

The most striking structural distinction between this and the other 5 spruce *Chermes* is in the antennae. The constrictions between joints III, IV, V are very inconspicuous so that these joints from some positions appear almost to be consolidated into a single long terminal joint. It was this character that suggested the specific name. The antennae of *consolidatus* are distinctive in one other respect, two of the four terminal hairs are developed into strong spines (Fig. 124a). This is not true of any of the other 5 spruce species.

Apterous oviparous form on larch.

On August 1, 1909, apterous oviparous forms in woolly mass on larch twigs were common. Although the connection was not traced I believe these to be *consolidatus* Fig. 126 was drawn from one of this collection.

CHERMES FLOCCUS Patch.

Like *Chermes pinifoliae* Fitch, this species develops in galls on black and red spruce and migrates to the needles of the white pine to oviposite. Both the galls and the insects, however, of these two species are too distinct to be in any respect confused.

These galls (fig. 134) were first collected on black spruce at Orono, July 10, 1909. They resemble galls of *similis* Gillette but are more compact and better formed than any galls of *similis* which were taken this season in Maine. They occurred in great numbers in this vicinity on red and black spruce. They are terminal and comprise the total deformed shoot. In length they vary from about ¾ to 1¾ inches. The surface of the gall is green in some while some have a dark purple tinge near the base of each needle, giving the gall a purple cast. The needles of the gall are not much dwarfed and are a normal spruce green. Figs. 135 and 136 give cross and longitudinal sections of this gall.

On account of the loose structure of the gall, syrphus maggots were very abundant within, feeding on the *Chermes* nymphs.

The pupa remains within the gall until after the last molt and the winged migrant emerges ready for flight.

Pupa. (Fig. 112). Described from specimen removed from gall shortly before the last molt. Length of body about 1.8 mm. Head, antennae, wing pads and legs dark or dusky, prothorax and abdomen rather dull reddish, thorax yellowish red and paler than abdomen. Entire body pulverulent. Wax gland areas on prothorax, thorax and abdomen are plainly located under a Zeiss binocular, by warty appearance of live specimen. These areas are: head with 2 large anterior and 2 larger posterior groups; prothorax with prominent lateral groups, also 2 small median anterior groups and 2 large posterior groups; mesothorax with prominent lateral areas, large median groups and small anterior groups; metathorax with 2 median groups in line with these on head and pro- and meso-thorax and abdomen; abdomen with lateral groups on segments I-VIII, large median groups on segments I to VI and a row midway between the lateral and median groups on I to VI. None of the pore-groups are merged in the pupa.

Migrants from spruce gall to pine. (Fig. 110) 1.5 mm.-2.1 mm. long with wing expanse 5. 0-mm.-5.6 mm. Freshly molted individuals have a yellowish red body and pale buff wings. The antennae are characterized by the exceedingly large sensoria on joints III, IV, V. Each sensorium comprises the entire surface of the joint except the extreme proximal and distal portions and a narrow ridge connecting these. The constrictions between joints are abrupt. III and IV are subequal and V is longer and not so thick. The wings are rather narrow. 1st A in the fore wing curves, the convexity being distad. M of the hind wing curves, the concavity being distad. Large wax gland areas occur on head and the three thoracic segments. On the abdomen lateral groups are present on perfectly distinct darkened areas on segments I-VII, IV, V, and VI are transversely banded by wax pores across the dorsum. Merged median groups occur on I, II, III and on III a separate group (sometimes absent) midway between the median and lateral groups. I and II are without wax areas between the median and lateral groups.

These winged forms migrate, from the middle to the last of July near Orono, to pine needles where they oviposite .(Fig. 133.) The ovipositing females secrete considerable wax from head glands as well as over the rest of the body so that they are a decidedly flocculent and not pulverulent species. This character alone would distinguish them from *pinifoliae* and is chosen for the specific name on that account.

In the woods these migrants were found abundant on the white pine needles over egg clusters of about 40 eggs. Coming so much later in the season *floccus* finds both old and new growth pine needles available and deposits the egg mass indifferently on the old or new. *Pinifoliae* migrants occur in this region only on needles of previous years growth as they appear the middle of June.

Chermes floccus migrants are not so particular as *pinifoliae* as to which way they are headed, some migrants settling on the pine needles with head toward the tip and some with head toward the base.

Besides the out-of-door observation of the migrants on white pine, a laboratory test was given. July 19 a lot of galls from which *floccus* were emerging were placed in a cage among the following conifers which were kept fresh in vials.

July 21 migrants had settled and deposited egg clusters as follows:

Picea mariana (Mill.) B. S. P.	Black spruce	0
Picea rubra Dietr.	Red spruce	0
Picea abies (L.) Karst.	Norway spruce	0
Picea canadensis (Mill.) B. S. P.	White spruce	5
Abies balsamea (L.) Mill.	Balsam fir	0
Tsuga canadensis Carr.	Hemlock	0
Pinus laricio Poir.var.*austriaca* Endl	Austrian pine	0
Pinus sylvestris	Scotch pine	0
Pinus strobus L.	White pine	92
Thuya occidentalis L.	Arbor vitae	0

July 21, two small tips of white pine alone were put with *floccus* galls. In 48 hours 57 *Chermes* had oviposited on one and 117 on the other. These eggs began to hatch July 28.

CHERMES SIMILIS Gillette.

On July 9, 1909, my attention was called to some scraggly twigs of Norway spruce which proved to be deformed by *Chermes*. These galls resemble somewhat those of *floccus* but they are less regular. Fig. 142 pictures these. Winged specimens were emerging from these galls on date of collection. A search of white, red and black spruces resulted in taking the same galls on all these. These galls are very loose in structure and syrphus maggots freely helped themselves to their contents.

Galls from all these spruces contained pupae practically ready to molt and become the winged form, and also a few very small apterous oviparous individuals which were laying clusters of eggs in little woolly masses. These apterous forms were also found with their eggs in woolly masses along the stem and in one case on the outside of gall of *floccus* (fig. 134.) They were reddish brown and were .5 mm. to 1.0 mm. long.

The winged forms from the Norway spruce out of doors were migrating. On the other hand, the winged ones from black spruce galls were settling and ovipositing freely on black spruce. They are a flocculent species and their wings showed dark against the woolly mass which covered their abdomens and egg clusters.

What the life-cycle relation of the apterous oviparous forms is to the migrants appearing and ovipositing at the same time I do not know. They are here considered as *similis* though their identity is not proven. The galls of *similis*, however, were the only ones discussed in this paper in which apterous oviparous forms were found. Professor Gillette also records apterous females and their egg clusters to be present in galls of *similis*.

A cage test as to preference of spruces of the migrants was made. July 9, galls from black spruce were caged with uninfested black, white and Norway spruces. By July 13 a few migrants had settled on the Norway and deposited but a decided preference was shown for the white spruce upon which they settled in plentiful numbers and deposited eggs, remaining for a time on the little white woolly masses.

July 9, galls from white spruce were placed with uninfested white, black and Norway spruces. A large majority chose the white spruce. The eggs of this species hatched in about a week.

On trees where the infestation was heavy the terminal shoots were sticky and the needles somewhat ruffled. (Fig. 144). In many places portions of the spruce needles turned whitish yellow giving a "blighted" appearance to the shoot.

The winged form (fig. 113), varied exceedingly in size, part of the emerging ones being about 1.0 mm. long with a wing expanse of 3.0 mm.-4.0 mm. while the majority were larger, ranging from 1.45 mm. to 1.7 mm. with a wing expanse of about 4.8 mm. Color of body reddish brown, wings a little smoky. Wings much as in *floccus* with the veins having a little more tendency to straightness. Antennae are more like those of *pinifoliae* than any other, both as to general shape of joints and the relative size of the sensoria. The wax gland areas are: head with dorsal surface nearly covered by the two anterior and posterior groups which nearly meet; prothorax with large lateral area, two anterior and two posterior groups; mesothorax with lateral anterior group and two very large median groups; metathorax with median groups extending nearly across the segment; abdomen with large groups on I-VI, median groups on I-VI being largest on I and graduated to smallest on VI; a group of wax pores midway between the median and lateral series on segments II-VI, those on IV-VI being much larger than those on I-II (the group on I, of 2 or 3 openings only, is sometimes missing).

Certain striking resemblances of this Maine collection to *similis* as described by Professor C. P. Gillette* led me to submit balsam mounts, galls and illustrations to him. On the basis of this data he stated that he is unable to find any good distinguishing characters to separate this Maine material from *similis*. Professor Gillette's courtesy in determining this species enables me to introduce *similis* from Maine.

CHERMES PINICORTICIS Fitch.

It frequently happens that trunks of the white pine in Maine are more or less covered by the white secretion of this minute *Chermes* which gives the bark a moldy appearance (fig. 146). The infestation has been particularly heavy during 1908 and 1909, but during the latter season so many syrphus maggots were present preying upon the *Chermes* that these natural enemies seem likely to check its increase.

Though I have reared the winged forms of *pinicorticis*, I have made no special study of this species. Whether it confines itself to the pine or possesses an alternate host is not known. I have found the winged forms resting in abundance on needles of infested small white pines, from which they took flight at the slightest jar. Whether their destination was another species of plant or merely another white pine, the present knowledge of this species does not give basis to state.

Either the wing or the antennal characters of *Chermes pinicorticis* would serve to distinguish it from any of the 6 *Chermes* discussed in this paper, though its minute size alone would prevent confusion.

The fullest account of this species is by Mr. Storment published in the Appendix to the *Twentieth Report of the State Entomologist of Illinois*. In Mr. Storment's paper, as in others on *pinicorticis* since Mr. Shimer by error merged *pinifoliae* with *pinicorticis* about 40 years ago*, the NAME *pinifoliae* is confused with *pinicorticis* both in the discussion and bibliography. It is evident from the context, however, that neither Mr. Shimer, Professor Osborn or Mr. Storment had observed the INSECT *pinifoliae* and for this reason the mistake in synonymy is very easily corrected.

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* Chermes of Colorado Conifers. 1907.

CONCLUSION.

The present paper deals with six gall forming *Chermes* of Maine conifers. The gall host and the alternate host, where there is one, has been in each case ascertained. No attempt has been made to follow the development of the winter generation. With three species of *Chermes* making galls on the white spruce and four on black spruce in one locality it is apparent that a detailed study of the winter generations could only be carried on satisfactorily on conifers raised from seed under quarantine.

A glance at fig. 134 where *Chermes similis* is seen ovipositing on galls of *Chermes floccus* is sufficient to suggest the confusion possible.

Both the galls and the winged individuals give characters sufficient to determine these six species, however, and these have been figured in each case.

Illustrations. The photographs published are selected from many taken by Mr. R. L. Hammond and have been a constant aid in recording permanently certain changing phases of the work of these *Chermes*, and have been a necessary part of the study. The drawings were made by Miss Charlotte M. King who spent most of the summer of 1909 at the Maine Agricultural Experiment Station. The structural details for each form figured were worked out independently by Miss King. During the same time the writer studied carefully with each species the arrangement and number of wax gland areas, the character of the antennal sensoria, wing characters and other significant points and the drawings as they stand record both Miss King's observations and my own critical interpretation, no detail that seemed important being left until sufficient material was examined for a mutual agreement.

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* For discussion see pp. 277-289 in this present paper.

Technique. At the time these species were studied, live material was available both for the pupae and winged forms. The general form of the individual was sketched first from live material and such structures as could then be ascertained were indicated. Details were studied and drawings completed from balsam mounts. Live specimens in some cases were mounted directly in the balsam and a few desirable results obtained for immediate use. In each case, however, a large series of mounts was carefully made for study, drawings, and photomicrographs. Total mounts were most satisfactory after the general method (modified according to size, readiness of penetration of the fluids, etc.) indicated as follows:

Killed in hot 98 per cent alcohol,
One hour in 80 per cent alcohol,
One-half hour in 98 per cent alcohol,
Ten minutes in 100 per cent alcohol,
Ten minutes in tolu.

Antennal details were taken from head mounts. Wings were in each species mounted separately. Where total mounts did not bring out clearly the wax gland areas of both thorax and abdomen, severed specimens were prepared to facilitate the more rapid and thorough clearing.

This detailed account of the method of preparation is given in order that the character of the material used may be recorded. Certain groups of wax pores, for instance, were not rendered visible in one or two species except in dissected specimens and in most, a large series was necessary to settle the number definitely. Some variation occurs in the size and arrangement of the groups of wax pores, but individuals figured and described represent the typical wax pore areas as they were seen. As the wax pores are often difficult to see the most convenient specific characters will be found in the wing and antennal characters which are distinctive and within slightly varying limits were constant, for the extended collection in this locality at least.

Wing Vein Nomenclature.

For the nomenclature of the wing veins used here the reader is referred to *Homologies of the Wing Veins of the Aphididae, Psyllidae, Aleurodidae, and Coccidae, Annals of the Entomological Society of America,* June 1909.

NEW SPECIES.

It is possible that some of the species described as new may prove to be synonyms of European species, but as the inconvenience of a synonymy is so much less than the confusion of a composite species it seemed wise not to attempt comparison with European species until a careful study had been made of these *Chermes* as they occur in Maine.

The first brief descriptions of *floccus*, *consolidatus*, and *lariciatus* were published in Psyche, December, 1909.

CHERMES IN EUROPE.

Many important and admirable studies of *Chermes* species have been carried on in Europe by such careful workers as Blochmann, Börner, Cholodkovsky, Dampf, Dreyfus, Mordwilko, Nüsslin. A comprehensive review of this work with bibliography appeared in *Zoologisches Zentralblatt*, Dec., 1909. *Zusammenfassende Ubersicht. Die neueren Ergebnisse und Aufgaben der Chermes-Forschung von Prof. O. Nüsslin in Karlsruhe.*

HOST PLANTS.

The host plants in the following key are recorded solely on the basis of one season's careful collection in the vicinity of Orono. The list of host plants may need to be extended later but it is accurate so far as it goes. In recording the collections of the galls, the botanical distinctions between the red and black spruces has been observed, though entomologically these might pass for one species. *Chermes* at any rate does not pay any attention to the distinction.

KEY TO THE CHERMES OF MAINE CONIFERS.

A. Galls on black spruce (*Picea mariana* B. S. P.) and red spruce (*Picea rubra* Dietr.)

Gall terminal.

1. Gall conelike, needles modified to thin scales. Ripening mid-June. Migrants ovipositing on needles of white pine. (*Pinus strobus* L.) *pinifoliae.*

2. Scraggly deformed twig. Gall-needles not much abbreviated. Ripening first of July. Migrants ovipositing on spruce *Picea* sp. *similis.*
3. Gall usually well formed ¾-1¾ in. long. Needles not much abbreviated. Ripening mid-July. Migrants ovipositing on needles of white pine. (*Pinus strobus* L.) *floccus.*
4. Gall small, ½ inch or less, pink or pale green. Gall needles short. Ripening first of August. Species also found on larch (*Larix laricina* Koch.) *consolidatus.*

B. Galls on white spruce.
  Gall terminal,
    Scraggly deformed branch. Ripening first of July. Migrants ovipositing on spruce (*Picea* sp.) *similis.*
  Gall not terminal,
    1. Pine-apple shaped. Ripening last of July. Migrants ovipositing on needles of larch. (*Larix laricina* Koch.) *lariciatus.*
    2. Pine-apple shaped. Ripening mid-August. Winged form not migrating to oviposite. *abietis.*

C. Galls on Norway spruce, *Picea abies* (L) Karst.
  Gall terminal,
    Scraggly deformed branch. Ripening first of July. Migrants ovipositing on spruce, *Picea* sp. *similis.*
  Gall not terminal,
    Pine-apple shaped. Ripening mid-August. Winged form not migrating to oviposite. *abietis.*

EXPLANATION OF PLATES.

Fig. 108. *Chermes pinifoliae* Fitch. Migrant from spruce gall to needles of white pine. Figs. 109, 109a. Antenna.
Fig. 110. *Chermes floccus* Patch. Migrant from spruce gall to needles of white pine. Figs. 111, 111a. Antenna.
Fig. 112. *Chermes floccus,* pupa developing in spruce gall.
Fig. 113. *Chermes similis* Gillette. Form which emerges from spruce gall. Figs. 114, 114a. Antenna.
Fig. 115. *Chermes abietis.* Form which emerges from spruce gall. Fig. 116. Antenna.
Fig. 117. *Chermes abictis,* pupa developing in spruce gall.
Fig. 118. *Chermes lariciatus* Patch. Migrant from spruce gall to needles of larch. Figs. 119, 119a. Antenna.
Fig. 120. *Chermes lariciatus.* Migrant on needle of larch with egg mass nearly completed and showing through the thin transparent wings. Drawn from living specimen.
Fig. 121. *Chermes lariciatus.* Egg mass on larch needle.
Fig. 122. *Chermes lariciatus.* Pupa developing in spruce gall.
Fig. 123. *Chermes consolidatus* Patch. Migrant which develops in spruce gall. Figs. 124, 124a. Antenna. Notice two strong terminal spines.

Fig. 125. *Chermes consolidatus,* pupa developing in spruce gall.

Fig. 126. *Chermes consolidatus?* Apterous oviparous form on larch.

Fig. 127. *Chermes pinifoliae* Fitch. Migrants from spruce to white pine needles.

Fig. 128. *Chermes pinifoliae.* Mature galls from black spruce still green and just before opening.

Fig. 129. Branch of black spruce. *A* cone with tip broken, *B* four normal spruce tips, *C* four young galls of *pinifoliae.*

Fig. 130. Tip of black spruce. *A* cone which is purple, *B* normal tip, *C* deserted *pinifoliae* gall which is bright reddish brown.

Fig. 131. Deserted galls of *Chermes pinifoliae* on red spruce.

Fig. 132. White pine showing injury to new growth by the young *pinifoliae* which may be located by the white secretion on twig at base of new growth. Photographed July 23, 1909.

Fig. 133. *Chermes floccus* Patch, migrants from spruce galls, ovipositing on white pine needles.

Fig. 134. Galls of *Chermes floccus* on red spruce. The white objects on the outside of the gall are waxy secretions of *Chermes similis,* apterous forms, which are ovipositing on *floccus* galls as well as on the twig.

Fig. 135. Gall of *Chermes floccus* from black spruce. Cross section. Fig. 136. Longitudinal section.

Fig. 137. Twig of white spruce with galls of *Chermes abietis.*

Fig. 138. Galls of *Chermes abietis* from Norway spruce. Longitudinal section of gall which does not enclose the whole twig. Fig. 139. Longitudinal section of gall which completely encircles the twig.

Fig. 140. Twig of Norway spruce. Show deserted gall of *Chermes abietis* and the white molted skins along twig and leaves.

Fig. 141. Twig of white spruce with galls of *Chermes lariciatus* Patch. Gall at right deserted. Gall at left not yet opened.

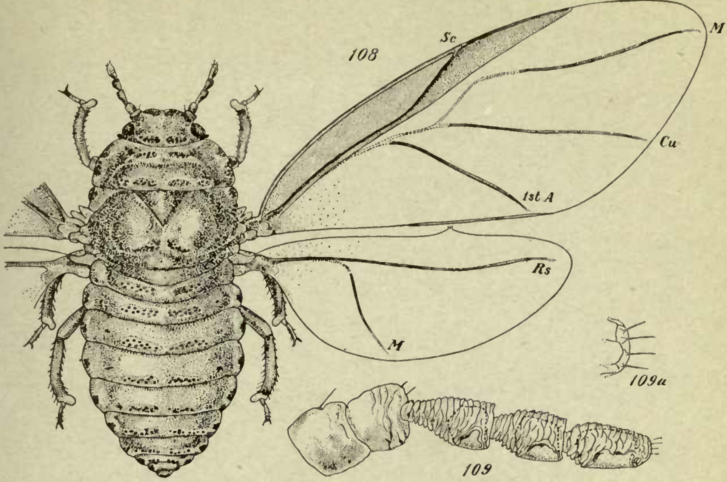
Fig. 142. Galls of *Chermes similis* Gillette on Norway spruce.

Fig. 143. Apterous flocculent oviparous females of *Chermes similis* showing white on stem of Norway spruce.

Fig. 144. Twig of black spruce showing injury to young of *Chermes similis.* Needles sickly yellow and covered with white flocculent secretion of the *Chermes.*

Fig. 145. Gall of *Chermes consolidatus* Patch on black spruce.

Fig. 146. *Chermes pinicorticis* Fitch on bark of white pine.



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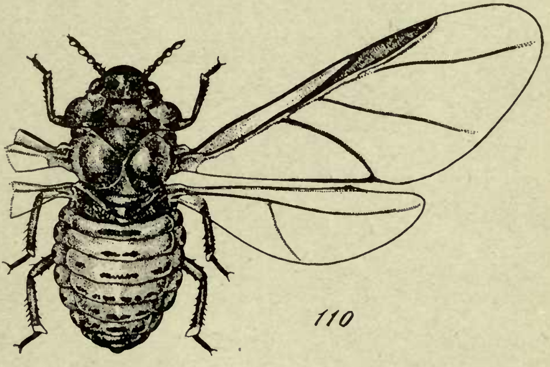

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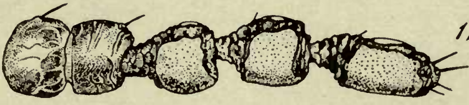

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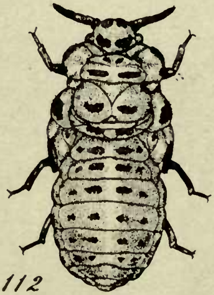

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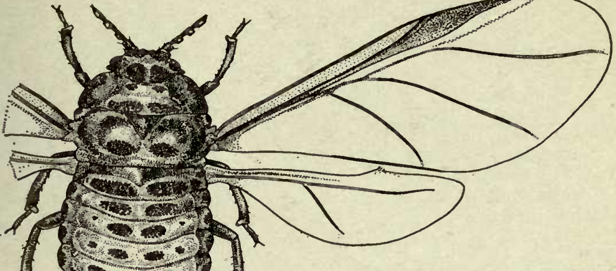

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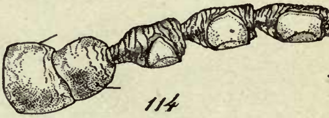

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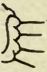

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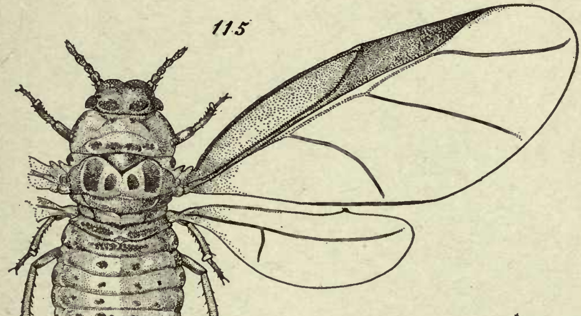

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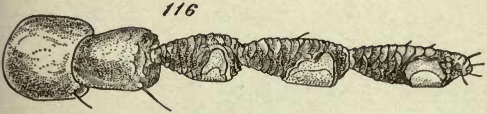

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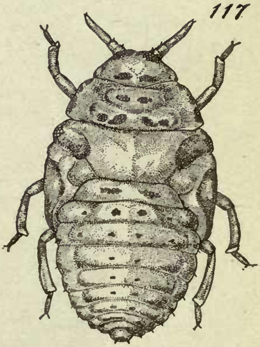

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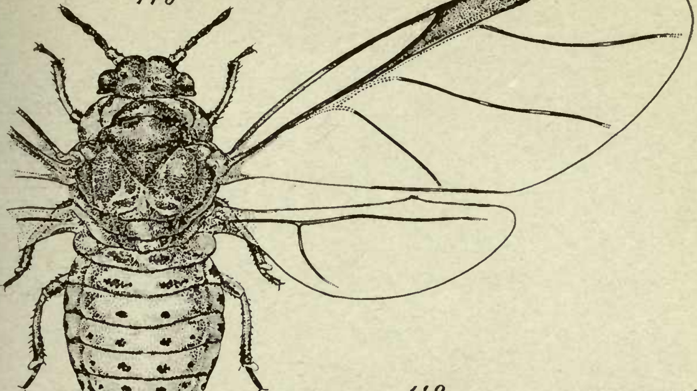

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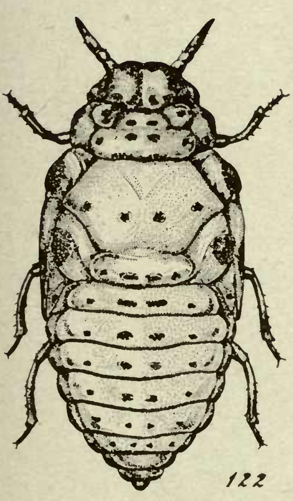

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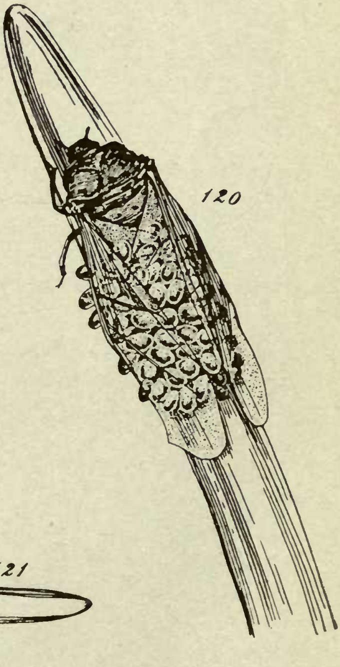

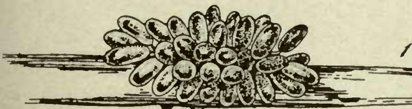

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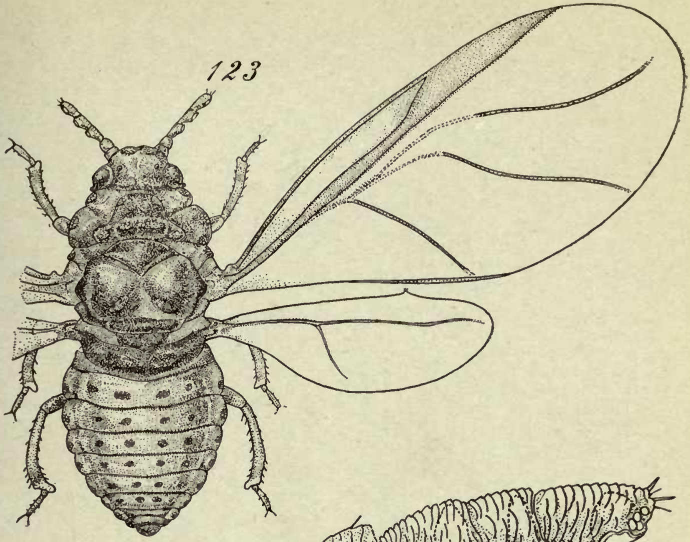
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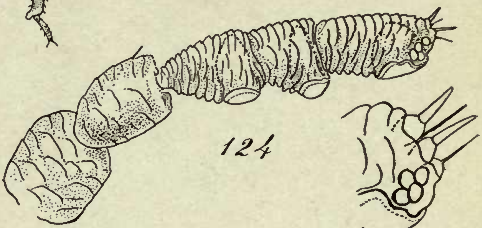
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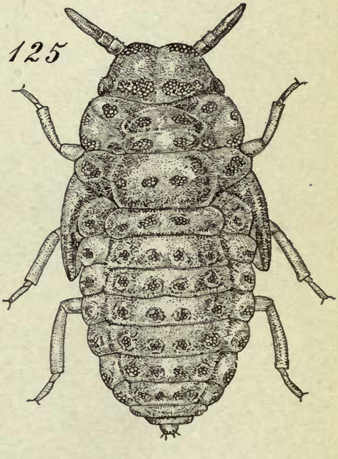
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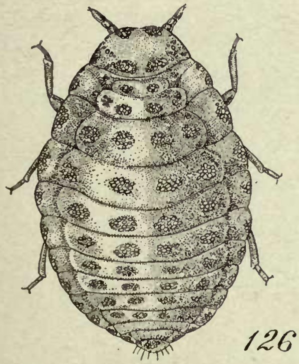
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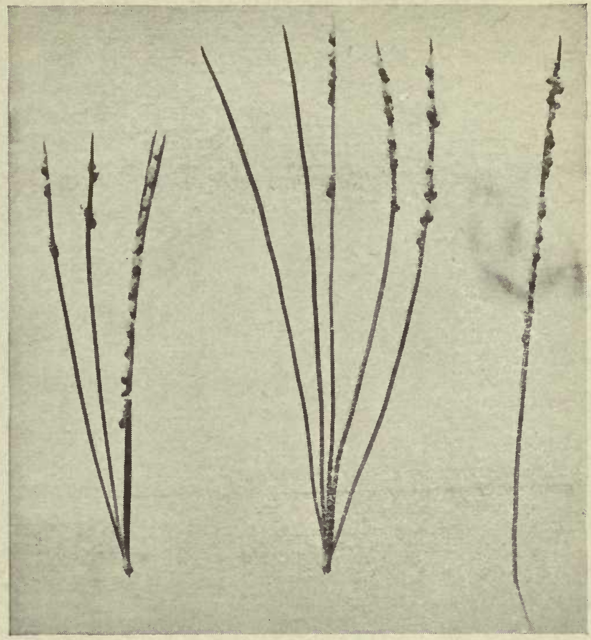
Fig. 127



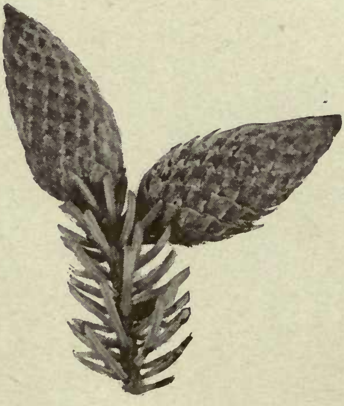
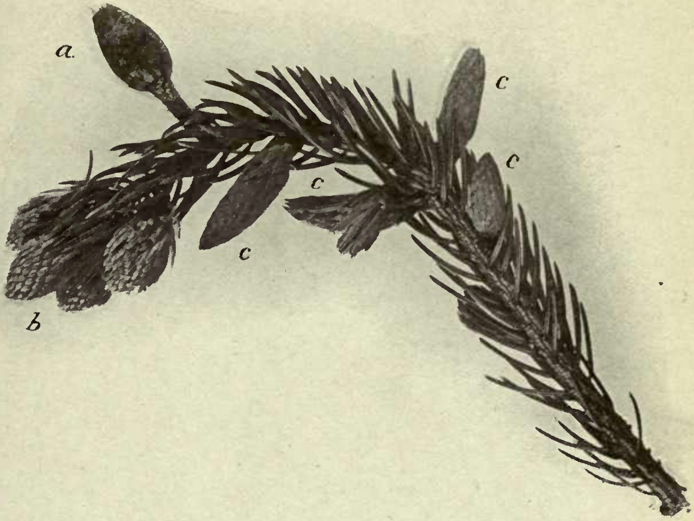


Fig. 128

Chermes pinifoliae Fitch. Fig. 127, Migrants on white pine. Fig. 128, Galls on black spruce.

Fig. 129



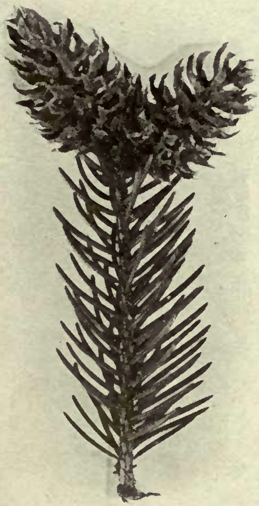


Fig. 131

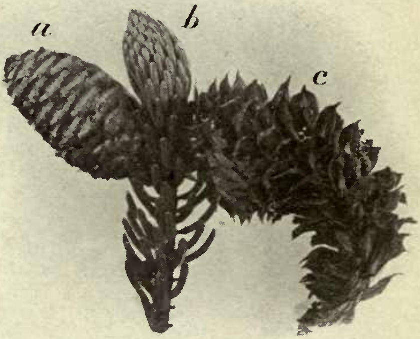


Fig. 130

Chermes pinifoliae Fitch. Galls on spruce.

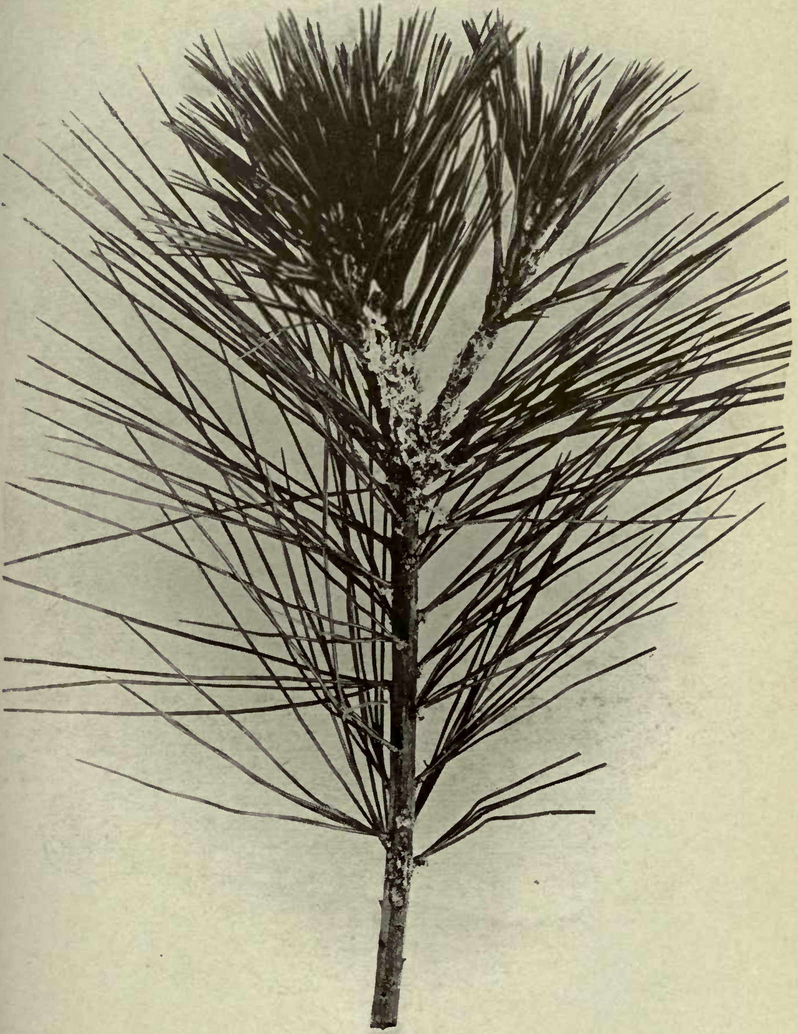


Fig. 132

Chermes pinifoliae Fitch. Young in white secretion towards tips of twigs of white pine

Fig. 133

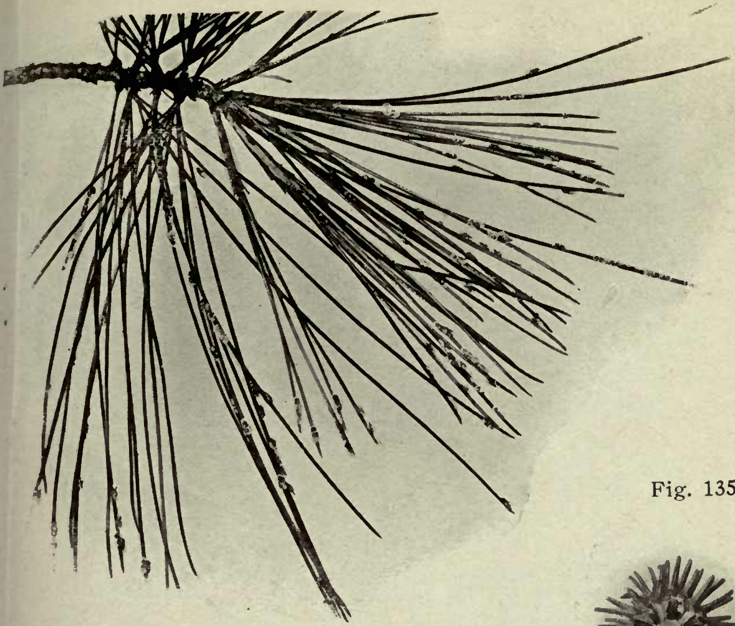
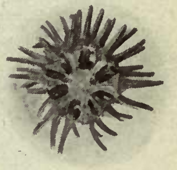


Fig. 135



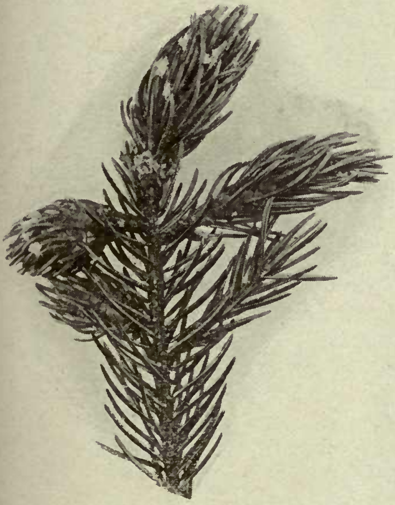


Fig. 134

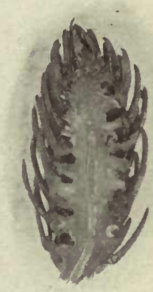


Fig. 136

Chermes floccus Patch. Migrants on white pine and galls on spruce

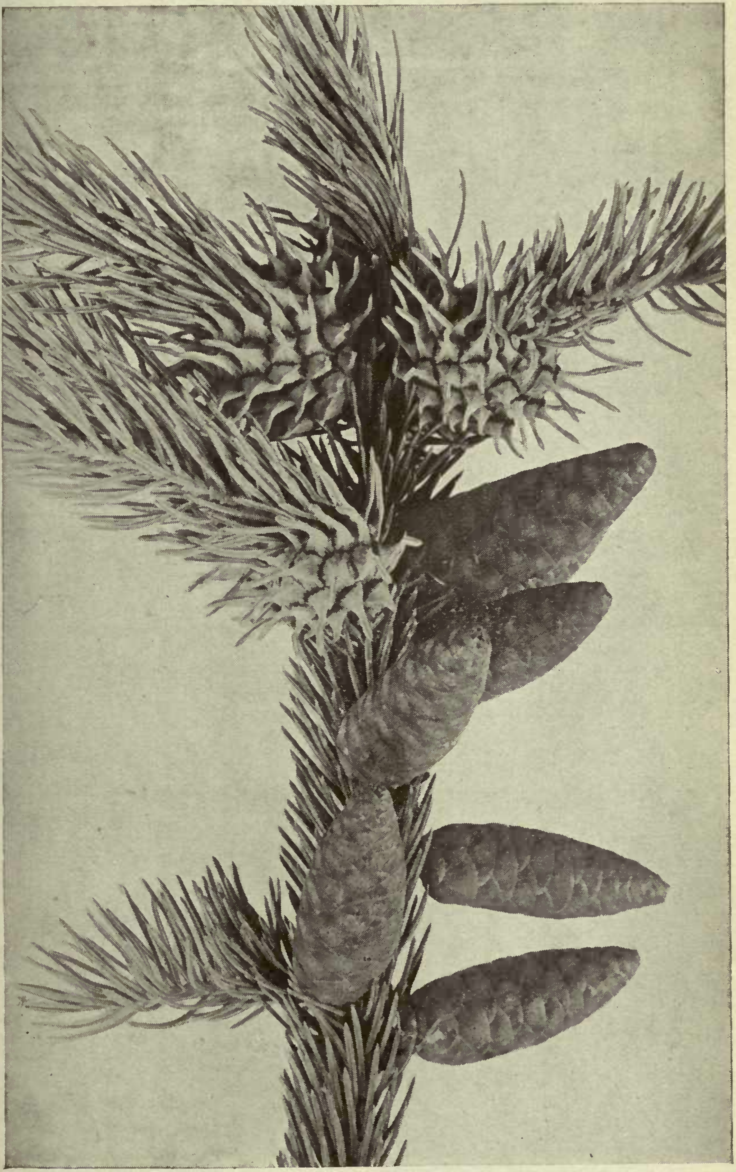


Fig. 137. *Chermes abietis* Linn. Galls on white spruce

Fig. 138

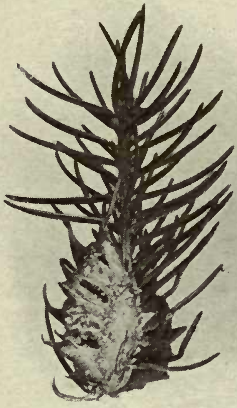
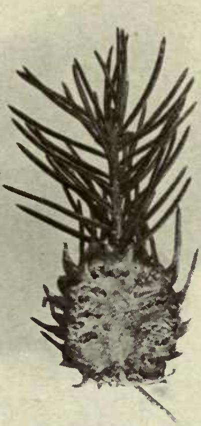


Fig. 139



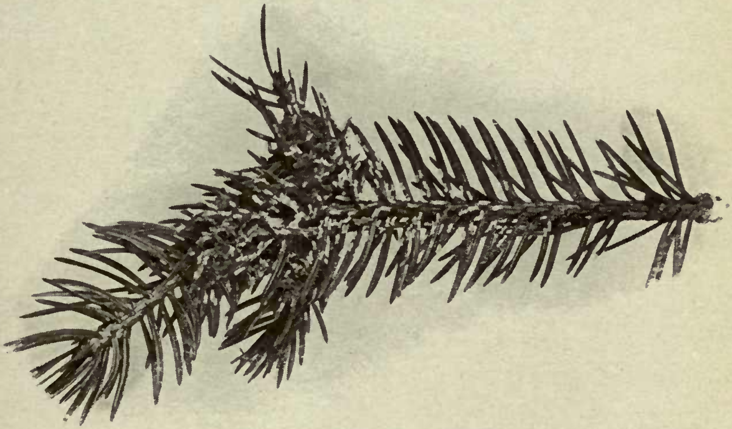


Fig. 140

Chermes abietis Linn. Galls on Norway spruce

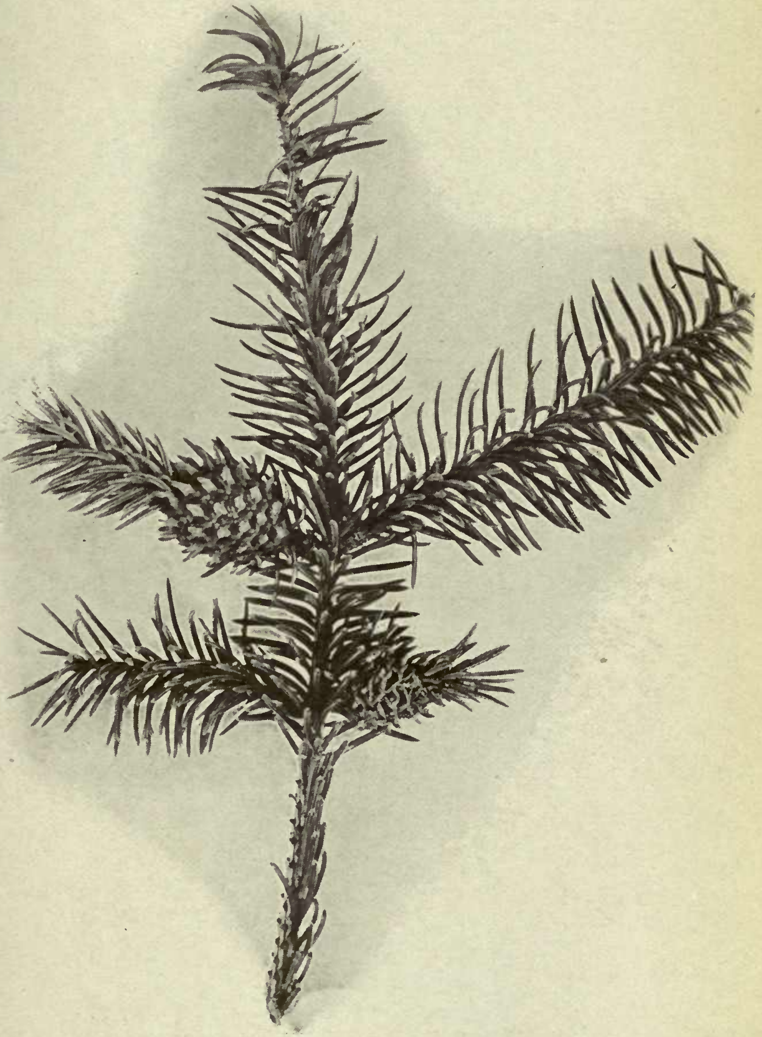


Fig. 141. *Chermes lariciatus* Patch. Galls on white spruce

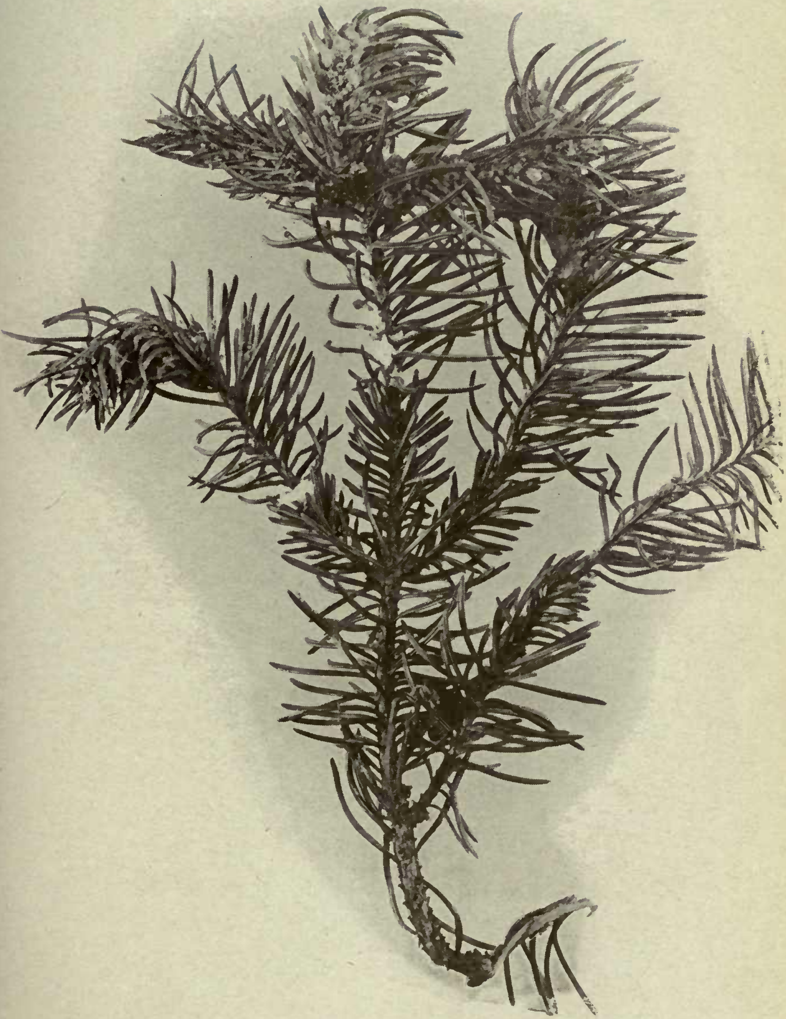
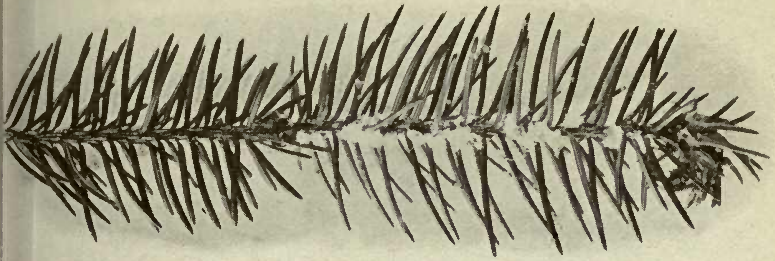


Fig. 142. *Chermes similis* Gillette. Galls on Norway spruce

Fig. 143



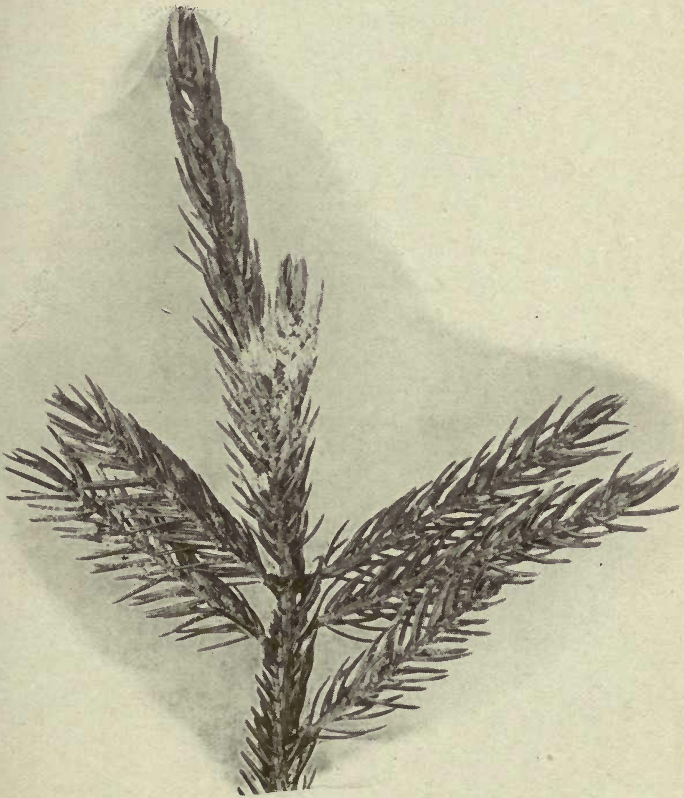
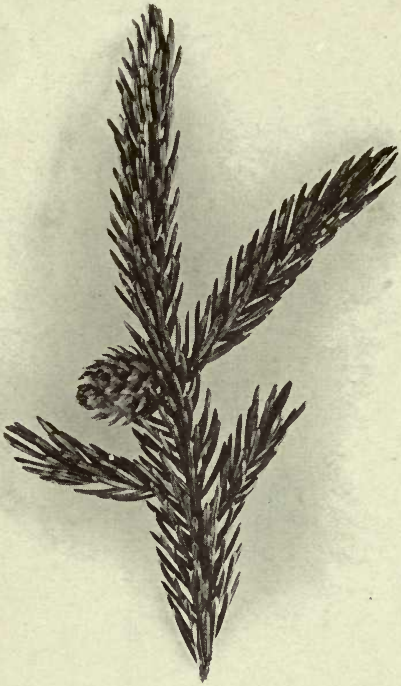


Fig. 144

Chermes similis Gillette

Fig. 145



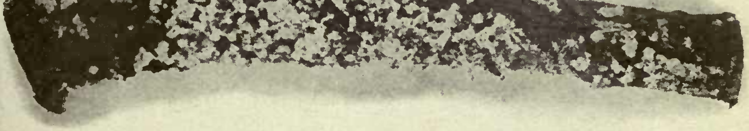


Fig 146

Fig. 145. *Chermes consolidatus* Patch. Gall on black spruce

Fig. 146. *Chermes pinicorticis* Fitch. On bark of white pine.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 182. JUNE 1910

FOUR RARE APHID GENERA FROM MAINE

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ORONO, MAINE.

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BULLETIN No. 182

FOUR RARE APHID GENERA FROM MAINE.*

By Edith M. Patch.

It often seems safer to describe American species of aphids as new and run the risk of a synonym than to record them under existing European names and thus incur the possibility of confusion. *S. glyceriae, M. abietinus* and *S. oblongus,* however, are very characteristic, the European descriptions are careful, apparently there is no confusion in European literature in regard to them and each occurs in Maine on the identical genus of food plant upon which it is recorded in Europe. I am venturing, therefore, to present them under their Old World names trusting that they may be able to keep them. *Mastopoda pteridis* though well known on account of its peculiar structure has been so seldom met with that it is appropriately included in this group of rare genera.

SIPHA GLYCERIAE.

1843. *Aphis glyceriae* Koch.
1860. *Sipha glyceriae* Passerini.

This most remarkable aphid excited my curiosity when I first came upon it on account of the fact that many of the aphids were completely submerged in the water on dead blades of grass and apparently in no wise disturbed or inconvenienced by this circumstance, but were to all appearances as comfortable as those above water on live blades.

In structure this species is no less striking than in habits. The body is very flat and appressed to the leaf. The entire body is armed with stout spines. The cornicles are circular openings elevated very slightly above the surface of the abdomen. The beak is stout and short extending to the second coxa. The 5-jointed antenna is short, not reaching the abdomen. The eyes are small but prominent as they protrude conspicuously from the sides of the head. The wings are transparent, narrow and much longer than the body, the venation is practically that of *Macrosiphum.* It is a green species with the abdomen dotted with darker green.

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*Papers from the Maine Agricultural Experiment Station: Entomology No. 44.

The single large collection made by the writer was taken June 22, 1909, from rush, *Juncus* sp., growing in a marsh pool at Orono. Alate and apterous viviparous forms, nymphs and pupae comprised this collection. Figures 198-205 present photo-micrographs and drawings of this species.

Measurements made from balsam mounts are as follows:—
Apterous viviparous form: Total length 2.25 mm.-2.55 mm. Antenna I, 0.06 mm.; II, 0.075 mm.; III, 0.21 mm.; IV, 0.1 mm.; V (base) 0.11 mm., (spur) 0.11 mm. No sensoria except distal ones of IV and V. Fig. 204.

Winged viviparous form: Total length 1.95 mm. Length of fore wing 2.85 mm. Length of hind wing 1.56 mm. Antenna I, 0.05 mm.; II, 0.05 mm.; III, 0.18 mm.; IV, 0.125 mm.; V (base) 0.1 mm., (Spur) 0.125 mm. III with about 6 large circular sensoria. Distal sensoria on IV and V. The peculiar sensoria on V are well shown in figures 203-203a.

Antenna of pupa much like that of the apterous form. Fig. 205.

MINDARUS ABIETINUS Koch.

The first collection of *Mindarus* in Maine was a single winged specimen taken at Orono June 16, 1905, from leaves of White Pine (*Pinus strobus*). This was kindly determined by Mr. Pergande as *Mindarus* (*Schizoneura*) *pinicola* Thos. the following winter. The next pine collection of this species made by the writer was near Orono June 30, 1909, when a single winged specimen was again taken upon a pine needle. These accord with the description of the winged form by Thomas and also with careful additional notes, measurements, and camera lucida drawings made by Mr. J. J. Davis from the type specimen* and kindly sent me.

---

*In the collection of Ill. St. Lab. of Nat. Hist., single winged specimen in balsam labeled "Pine Carb(ondale, Ill.) April 26, 1878."

However on June 11, 1908, a large collection of pale green pupae on the tips of balsam fir was brought to me. Many of these molted during the night and the winged aphids proved to be *Mindarus* and to all appearances *abietinus* Koch described from *Abies* in Europe. On June 14, 1909, a large collection of pupae was made by the writer from balsam fir and winged forms were again secured. These accord with the type specimen of *pinicola* Thomas and it is probable that the pine and the balsam *Mindarus* are the same species, though biological proof is yet lacking. Late in May, 1910, *Mindarus abietinus* occurred in enormous numbers at Orono both on balsam fir and spruce (*Picea canadensis*). The new growth became badly "ruffled" on infested twigs.

Pupa:—Body pale green and very pulverulent. Total length 2 mm. Antenna pale proximal half, dusky distal half, extends to middle of thorax. I, 0.075 mm.; II, 0.06 mm.; III, 0.21 mm.; IV, 0.11 mm.; V, 0.14 mm.; VI, 0.165 mm. Eyes dark. Beak extends to base of 3rd coxae. Wing pads a little dusky. Legs with femora and tibiae pale yellowish, tarsi dusky. Abdomen with fine white silky tufts in lateral rows on each side. Eight large wax gland areas occur in a lateral row on each side of abdomen. Other similar areas occur on the dorsum. These areas are somewhat circular and comprise about 80 or less minute wax pores. Color description from live specimens. Measurements and details from balsam mounts. Maine collection numbers 5-08 and 15-09. Figures 207, 211, 212. *Habits and Habitat.* Curling new tips of balsam fir (*Abies balsamea* Mill) and causing twip tips to look downy. Honey dew excreted in large quantities. June.

Migrant, Alate Viviparous ♀:—Head pale green, eyes dark. Beak extends to 3rd coxa. Antenna extends to abdomen. I, 0.06 mm.; II, 0.065 mm.; III, 0.36 mm.; IV, 0.225 mm.; V, 0.23 mm.; VI, 0.225 mm. III with about 12 large quasi transverse sensoria in an even row, extending nearly the whole length of III. IV, V and VI each with large sensorium at distal portion. The sensoria grouped about the large terminal sensorium of VI are distinct and separate. Spur of VI about one-third the length of the basal portion. IV, V, VI slightly imbricated. Thorax brown dorsal and ventral. Wings pale with dark but delicate veins. Stigma very long, curving to a point near distal tip of wing. R_s* long and not much curved. M with 2 branches like *Schizoneura* and obsolete at base. Cu and A both slightly curved making the cell between them slightly oval. Costal margin of wing strongly arched. Hind wing broad, venation practically as in *Schizoneura.* Length of wing about *3 mm.* Legs with proximal half pale, distal part dusky, tibiae and tarsi dark. Abdomen pale green, pulverulent. Total length of body about 2.1 mm. Color description from live specimens. Measurements from balsam mounts. Maine collection numbers 5-08, 15-09. Figures 206, 208, 209, 210.

Apterous viviparous ♀. Body pale green, pulverulent. Length 2 mm. Antenna I, 0.07 mm.; II, 0.07 mm.; III, 0.15 mm.; IV, 0.085 mm.; IV, 0.11 mm.; VI, 0.14 mm.

This form was present thickly packed in tips of balsam fir and spruce in May, 1910. They matured about May 25. The honey dew was so abundant that the trees could not be touched without a sticky shower resulting. Maine collection numbers 21-10, 22-10.

Habits and Habitat. Developing in curled tips of *Abies balsamea* Mill and *Picea canadensis* Mill. Migrating from infested *Picea canadensis* twigs about mid-June, immediately after acquiring wings.

Professor O. W. Oestlund has collected this same species near the Pacific Coast.

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1887. *Schizoneura pinicola* Oestlund. Aphid. Minn. p. 30. Listed as not found in Minn.

1890. *Schizoneura pinicola* Packard. Forest Insects. p. 804. 4-line quotation from Thomas.

1899. *Schizoneura pinicola* Chittenden. Bul. Div. Forestry, U. S. Dept. Agric. *22*: 60. Mere mention.

1899. *Schizoneura pinicola* Britton. 22d Ann. Rept. Conn. Agr. Expt. Sta. for 1898. Brief account of an infestation of pine in Connecticut. Doctor Britton kindly informed me May 13, 1910, that the species concerned in this infestation was not given detailed study.

---

*For terminology of wing veins, the reader is referred to *Homologies of the Wing Veins of the Aphididae.* Ann. of the Ent. Soc. of America, Vol. II, No. 2.

1901. *Schizoneura pinicola* Hunter. Aphid. of N .A. p. 83. Bibliography.

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1906. *Schizoneura pinicola* Felt. Insects affecting Park and Woodland Trees. *2*: 753. Mere mention.

1909. *Mindarus abietinus,* Patch. Homologies of the Wing Veins of the Aphididae. Ann. of the Ent. Soc. of Am. Vol. II, No. 2. pp. 14, 15. Figs. 18, 19, 20. Discussion of the tracheation and venation of the wings.

SYMDOBIUS OBLONGUS.

On July 17, 1908, this striking species was collected at Orono where it was found to be gregarious upon the branches of birch (*Betula papyifera* Marsh). It occurred largely upon the growth of the previous season, and was difficult to collect on account of its tendency to drop from the branch at the slightest jar. Nymphs, pupae, and apterous and alate viviparous forms were taken in this collection. On August 20, 1908, a second collection of the apterous viviparous form was collected from the branches of birch (*Betula papyifera* Marsh) where it occurred in small colonies. The broad white bands on the dark antennae and the heavy shadowing of the wing veins make this a distinctive species.

Alate viviparous form. Head brown with red eyes. Antenna with I, II, III dark and IV, V, VI with proximal portion white and distal portion dark making a distant and conspicuous banding. I, 0.105 mm.; II, 0.055 mm.; III, 0.7 mm.; IV, 0.45 mm.; V, 0.4 mm.; VI (base) 0.2 mm., (Spur) 0.2 mm. Notice that the spur is very short. III, IV, V and VI are imbricated. About 15 protruding sensoria occur in a row on III, single large sensorium at distal part of V. VI with usual sensorium at base of spur, and separate attendant sensoria. Beak extends to second coxae. Prothorax and thorax brown. Wings with brown veins heavily shadowed. Length of wing 2.95 mm. Legs brown. Abdomen hirsute (spiny), brown with heavy transverse bands of darker brown. Cornicles yellowish white, short, broad, somewhat constricted at the middle, and with flaring opening. Figures 215-219. Color notes from live material. Measurements from balsam mounts. Maine collection number 41-08.

Apterous viviparous form. Head dark brown with red eyes.

Antenna with I, II, III dark, and IV, V, VI with proxmal portion white and distal portion dark. Imbrication and sensoria as in alate form. I, 0.15 mm.; II, 0.10 mm.; III, 0.87 mm.; IV, 0.54 mm.; V, 0.45 mm.; VI (base) 0.22 mm., spur 0.24 mm. Prothorax and thorax brown. Legs brown. Abdomen spiny, brown with darker transverse bands. Cornicles as in alate viviparous form.

The nymphs are brown and thickly beset with spines. Color notes from live material. Measurements from balsam mounts. Maine collection numbers 41-08, 61-08.

1837. *Aphis oblonga* von Heyden, Entomolog. Beiträge in Mus. Senckenberg.
1843. *Aphis oblonga.* Kaltenbach Pflanzenläuse, p. 133, species 101.
1844. *Aphis oblonga.* Ratzeburg. Forstinsekten III, p. 219.
1848. *Aphis oblonga.* Walker. Descriptions of Aphides. Ann. and Mag. Nat. Hist. Ser. 2.
1854-1857. *Callipterus oblongus.* Koch Pflanzenläuse, p. 219. Figs. 292, 293, 294.
1894. *Symdobius oblongus* Mordwilko. Rab. Lab. Zool. Kab. Varch. Univ. (K. Faune Anat. sem. Aphid) p. 54.
1895. *Lachnus (Callipterus Koch) oblongus.* Judeich und Nitsche. Forstinsektenkunde. (Mere mention) p. 1211.

MASTOPODA PTERIDIS Oestlund.

Since this curious species was recorded in 1886 from Minnesota, no account of a second collection has been published. It is interesting in this connection to include a brief description of the apterous form which the writer collected from brake fern near Orono, August 6, 1906. This was kindly determined for me by Professor Oestlund.

Apterous viviparous form: Head and thorax yellowish white, eyes dark. Antenna about the length of body with I, II and proximal half of III white, rest dark. Antenna 5-jointed (6 if spur is counted as distinct joint as in original description). I, 0.1 mm.; II, 0.07 mm.; III, 0.55 mm.; IV, 0.25 mm.; V, (base) 0.10 mm. (spur) 0.65 mm. III without sensoria. IV with single large sensorium at distal end. V with usual sensorium at base of spur. III, IV, V imbricated. The legs are the most characteristic part of this species, the tarsi being atrophied. Abdomen is yellowish white with dark scrawls and tracings. At base of cornicle is a round bright orange spot which may be absent but is apparently characteristic as it is usually found both in the mature apterous form and in the young nymphs. Cornicles long (0.45 mm.) cylindrical and dark brown. Total length of body 1.65 mm. Color description from living material. Measurements from balsam mounts. Maine collection number 98-06. Figures 213, 214.

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1887. *Mastopoda pteridis,* Oestlund. Aphid. of Minn. p. 49. Description and brief account.

1898. *Mastopoda pteridis,* Packard. Textbook of Ent. pp. 103, 104. Fig. 114. Figures the leg.

1910. Wilson. Pro. Ent. Soc. Wash. Vol. *12,* p. 28. *Mastopoda pteridis,* Oestlund, is by error considered a synonym of *Aphis pteris-aquilinoides,* Raf.*

EXPLANATION OF PLATES.

Figures 203-207 were drawn by Miss Charlotte M. King. The photomicrographs were taken by Mr. Royden L. Hammond.

Figs. 198-205. *Sipha glyceriae.* 198, Winged viviparous form; 199, pupa; 200, wings; 201, apterous viviparous form; 202, tip of abdomen of apterous viviparous form giving a good view of the cauda; 203, antenna of winged viviparous form; 204, antenna of apterous viviparous form; 205, antenna of pupa.

Figs. 206-212. *Mindarus abietinus.* 206, Antenna of winged viviparous form; 207, antenna of pupa; 208, wings; 209, tip of abdomen of winged form lateral aspect; 210, tip of abdomen

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*Although it would seem to be impossible on the basis of the original description of *Aphis pteris-aquilinoides* to recognize this species if one should chance to re-discover it, fortunately Rafinesque included one character by which his species can readily be separated from *pteridis* Oestlund for he states that the "appendages" (*i. e.* cornicles) are short in *pteris-aquilinoides.* It is perhaps safe to hazard the guess that even Rafinesque would have noticed the atrophy of the tarsi if he had collected so remarkable a species.

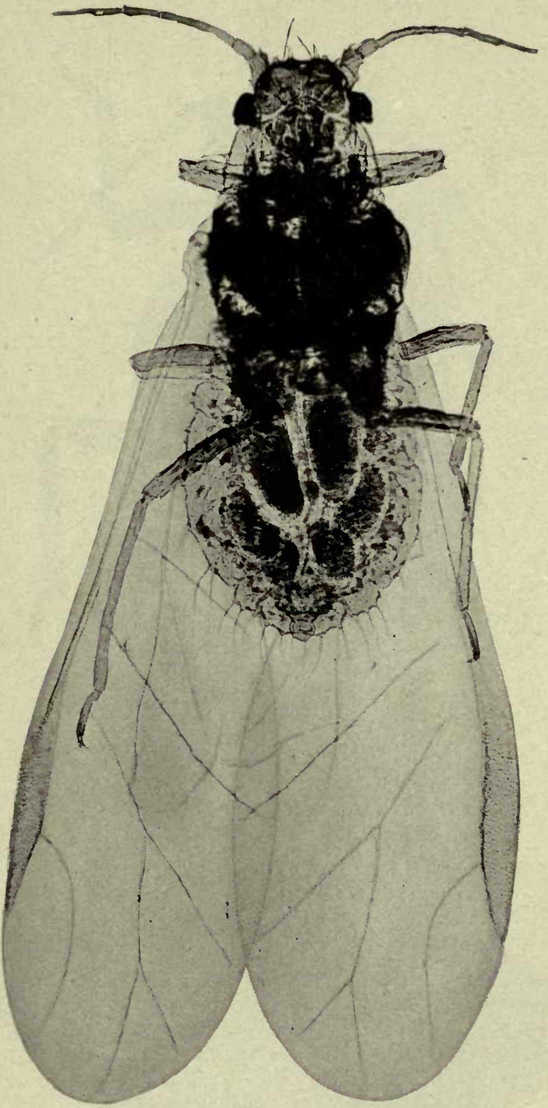
As Rafinesque's papers are not easily accessible, his description of *Aphis pteris-aquilinoides* is quoted entire as follows:

"6. *Aphis Pteris-aquilinoides.* (*P. aquilina Amer. Auct.*) Body pale green, oboval, one line long; eyes brown, antens half a line long; appendages very short." Rafinesque designated the cornicles by the term "appendages."

of winged form dorsal aspect; 211, a single dorsal wax-gland area from pupa, greatly magnified; 212, pupa just before molting, showing the lateral and part of the dorsal wax-gland areas on pupal skin.

Figs. 213-214. *Mastopoda pteridis,* apterous viviparous form and antenna.

Figs. 215-219. *Symdobius oblongus.* 215, wings; 216, caudal tip of abdomen of winged form showing cornicles; 217, antenna showing the alternate banding of light and dark; 218, III, showing sensoria; 219, III, showing sensoria in profile.



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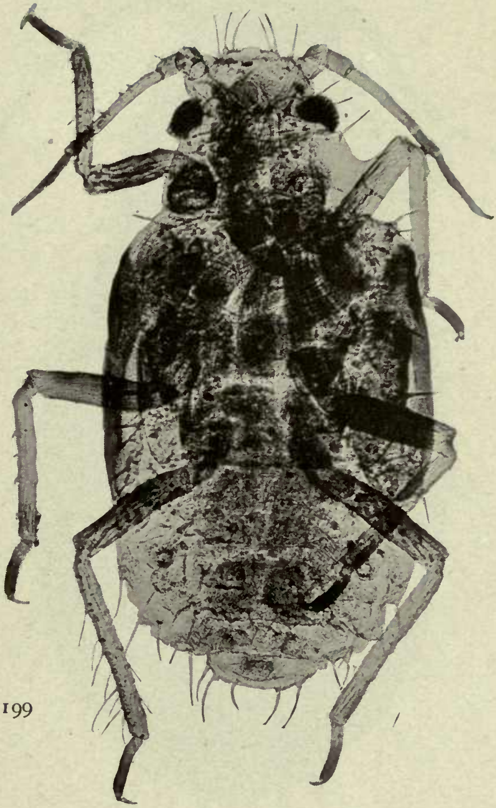

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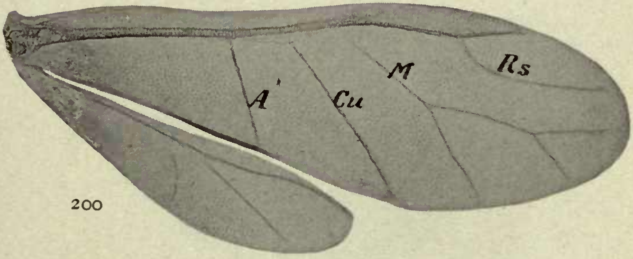

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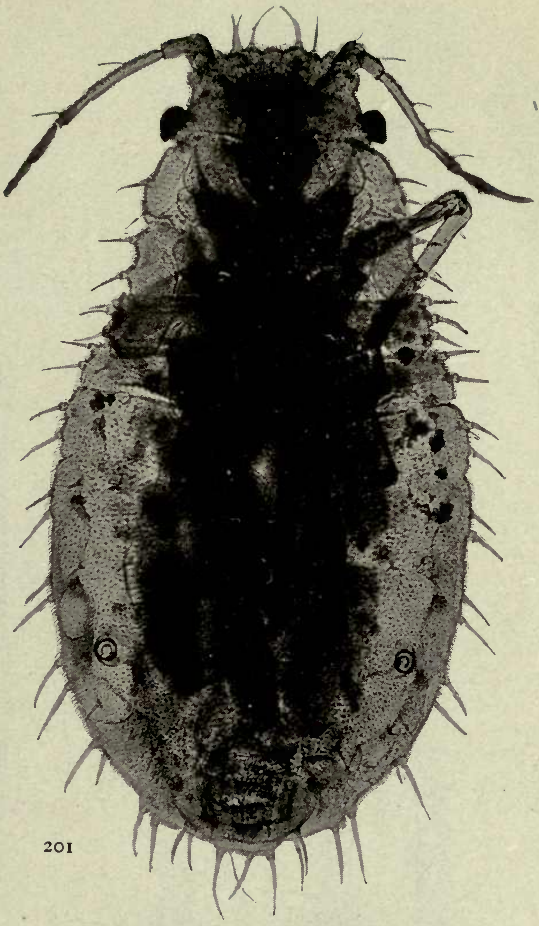

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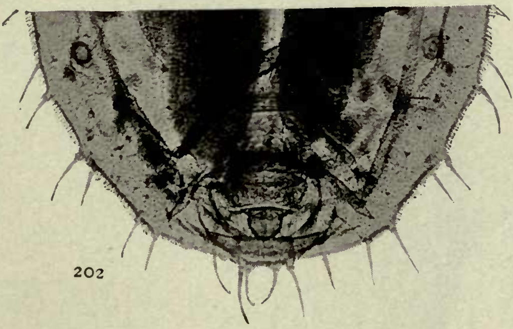

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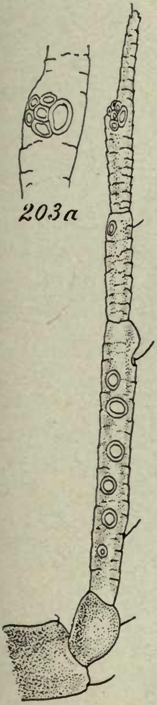

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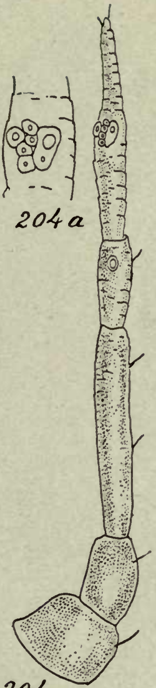

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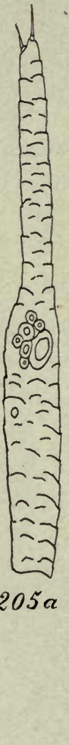

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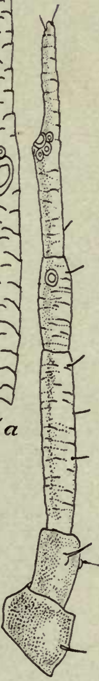

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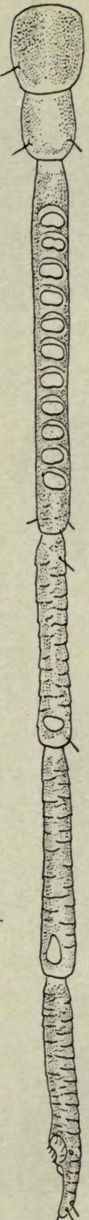

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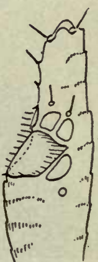

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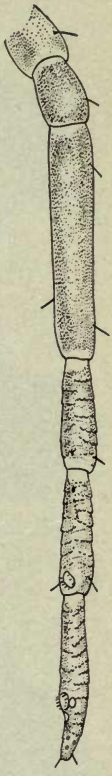

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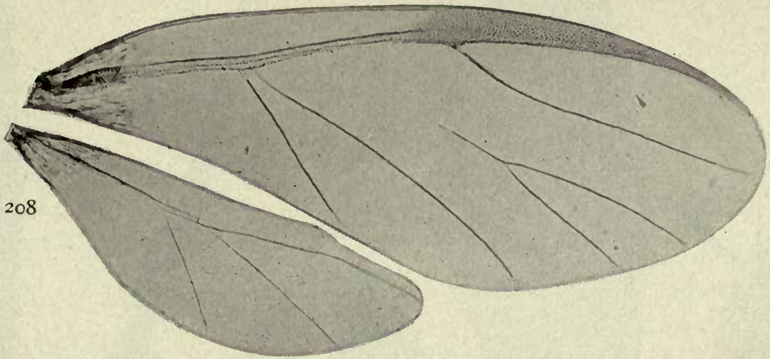

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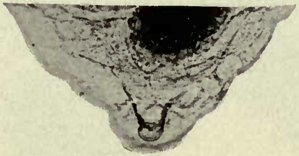

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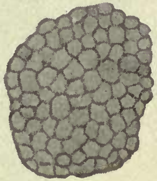

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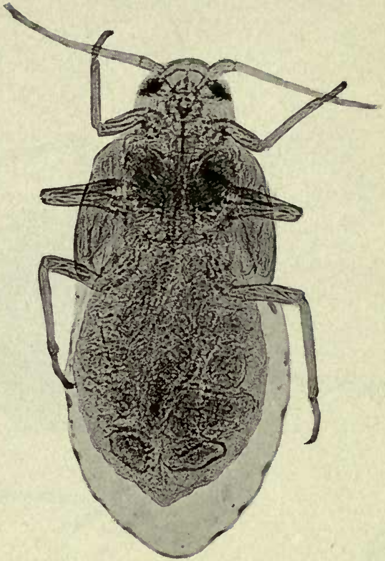

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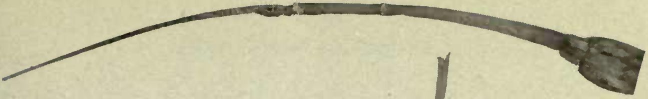

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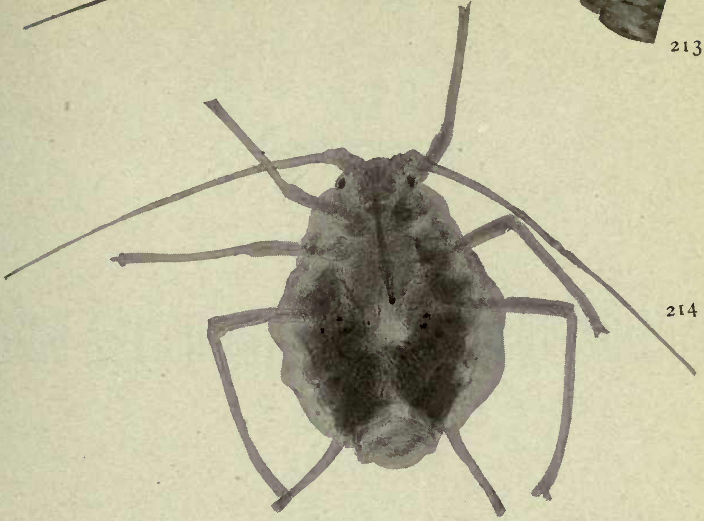

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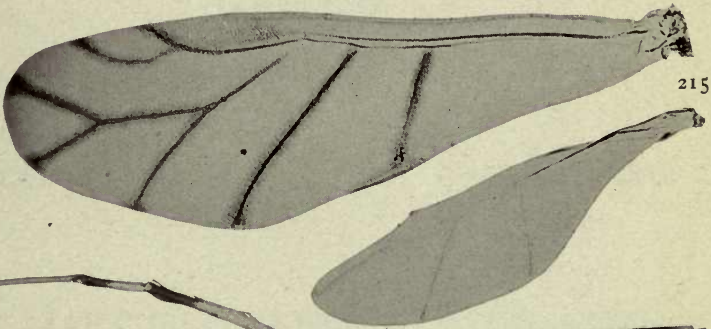

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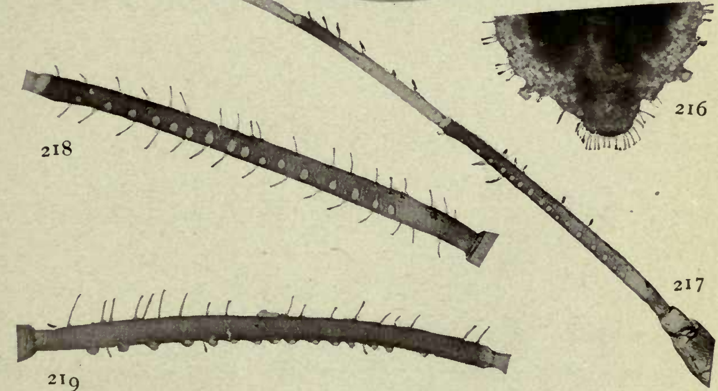

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Maine Agricultural Experiment Station

ORONO

BULLETIN No. 203 AUGUST, 1912

ELM LEAF CURL AND WOOLLY APPLE APHID.

This bulletin contains a report of the migration of the woolly aphid from elm leaf curl to apple, with special reference to the economic significance of this discovery for nursery stock and young orchards. A general account of this serious and wide spread apple pest is included.

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BULLETIN No. 203.

ELM LEAF CURL AND WOOLLY APPLE APHID.*

EDITH M. PATCH.

The dual personality of certain aphid species is a condition which, before it is detected, betrays the economic entomologist into many futile combative attempts; but on the other hand the same duality may reveal, when once discovered, the most vulnerable point of attack. It is not necessary to go out of our own state for illustrations. The discovery that *Chermes abieticolens* Thomas 1879 which makes cone-like galls on black and red spruce is the same species as *Chermes pinifoliae* Fitch 1858,** which lays eggs on new growth white pine for progeny that render the pine shoots weakened and unthrifty, gives the landscape gardener his clue. If he treasures the beauty of a group of white pines he would do well to exclude red and black spruces from the vicinity, or conversely if he wishes to grow black spruces with normal branches it is an indiscretion to place them near white pines. Again, when once it was ascertained that the common Alder Blight, *Pemphigus tessellata* Fitch 1851, was masquerading on the maple (*Acer saccharium* L.—*dasycarpum* Ehrh. and cultivated varieties) as *Pemphigus acerifolii* Riley 1879,† the owner of ornamental cut leaved maples had a theretofore unsuspected means of protecting their foliage by the control of the pest on its alternate food plant, the alder, which in many circumstances is an easy point of control.

The economic application of the case in hand is apparently as direct and simple as the two just cited and since we are here concerned with one of the most serious of the apple tree pests, the significance of the recent discovery * that the elm leaf curl harbors the "wolf in sheep's clothing" is an important factor to be taken into consideration in dealing with the woolly aphid of the apple.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 58.

** Bulletin 173 Maine Agricultural Experiment Station.

† Entomological News, 1908, p. 484; Journal of Economic Entomology 1909, Vol. II, p. 35; Bulletin No. 195 Me. Agr. Exp. Sta., Feb. 13, 1912.

While working over some elm aphides several winters ago I found that I was unable to separate on structural characters certain collections of *Schizoneura americana* (causing and inhabiting elm leaf curl) from certain collections of *Schizoneura lanigera* (the troublesome woolly aphid of the apple). Collections could be selected which showed apparently significant antennal differences but others could be selected which could only be separated by reference to the tree from which they had been taken. Notice in this connection antennal figures 449 to 459. (As a study of the antennal variation in 1,000 individuals of this species is nearly ready for press, further discussion of this point is not necessary here.)

This circumstance brought no real conviction, for *lanigera* (described in 1802) has been under economic surveillance for more than 100 years and Riley (1879) gives descriptions of seven consecutive generations of *americana,* from the stem mother to the true sexes inclusive, all on the elm. On the other hand spring and return migrants of *americana* had been recorded from the widely separated localities of Idaho (Aldrich 1901), Kansas (Sanborn 1904) and Maine (Patch 1910) and their summer residence was still a mystery. Moreover the overwintering of *lanigera* on the apple roots was, though confusing, no argument against another host for the winter egg, for, as was shown for the Alder Blight, the all year presence of apterous forms on the alder was coincident with a migration to the maple for the deposition of the true sexes and the winter eggs. (Bulletin No. 195 of this Station).

Field observations were made during two seasons with this problem in mind but brought no solution, the summer occurence of *rileyi* which I consider to be an elm bark form of *americana* (See Me. Sta. Bul. 181, p. 237) complicated the situation, while the fact that both hosts were under out door conditions, not easy of control, left too much room for doubt.

This past winter, however, material under control conditions was secured by raising seedling apples in the greenhouse where infestation from the woolly aphid was rendered impossible. Leaf curl from elm with pupae and alate forms were secured from the south some time before material at the same stage would be available here, and migration tests were made. The winged forms from the elm were caged over seedling apples, and their progeny, growing along creases where the thin bark is scaling back, in the axils of the leaves and on exposed roots of the apple seedlings, covered by typical flocculent white secretion, are unmistakably the woolly aphid of the apple. (Fig. 448). The colony in the figure just cited was started May 12-13, by migrants from elm leaf curl. Their progeny thrived from the first and the photograph was taken May 29, the day on which the first apterous generation on the apple began to give birth to young.

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* Science, Vol. 36, p. 30. "Elm Leaf Curl and Woolly Aphid of the Apple."

On part of the seedlings similar tests were unsuccessful, the nymphs dying very soon or in one case after about two weeks tardy growth. This was probably due to aphid resistant seedlings, the apples from which the seeds were planted being from several different varieties, and as is well known all apples are not alike susceptible to attacks from the woolly aphid.

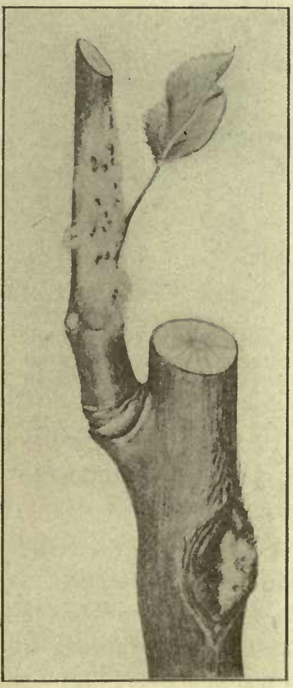

Fig. 438. Bark colonies of Woolly Aphid on apple. (From Alwood.)

Habits.

The woolly aphid occurs upon the apple as a bark feeder and is found upon branches, roots, and tender places on the trunk. These insects are covered by a white flocculent waxy secretion given off as fine filaments through pores in the skin and their colonies are thus readily detected by the masses of white "wool" which renders them conspicuous. (Figs. 438 and 448.)

On the roots its attacks induce enlargements or galls or swellings, and in the creases of these malformations the root form occurs in clustered masses. The injury to the trees is due both to the sucking up and exhaustion of the vital plant juices and to the poisoning of the parts attacked, as indicated by the consequent abnormal growths. Fig. 439.

The damage is particularly serious in the case of nursery stock and young trees and is less often important after the tree has once become well established and of some size. Where this insect is abundant all the roots of a young tree to the depth of a foot or so become clubbed and knotted by the gowth of hard fibrous enlargements with the results in a year or two of the dying of the rootlets and their ultimate decomposition with attendant disappearance of the galls and also of the lice, so that after this stage is reached the cause of the injury is often obscure.

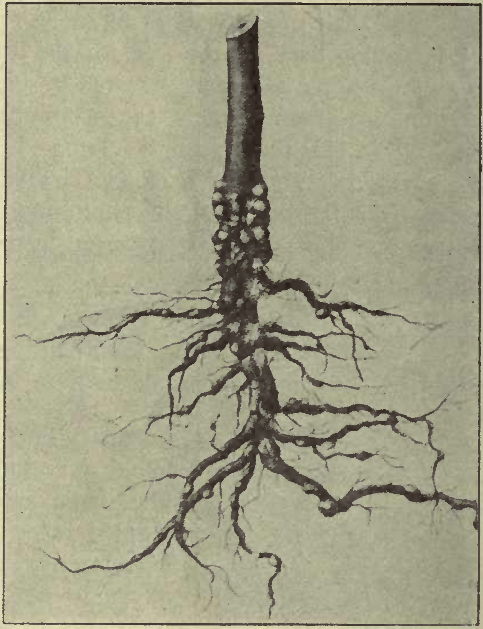

Fig. 439. Crown and root of young apple tree. showing characteristic swellings or galls produced by the root lice. (From Alwood.)

On the trunks the presence of the lice results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots, they collect particularly in the axils of the leaves, often eventually causing them to fall, and on the tender growth of the stems. The damage above ground, though commonly insignificant, is useful as an indication of the probable existence of the lice on the roots. A badly attacked tree assumes a sickly appearance and does not make satisfactory growth, and the leaves become dull and yellowish, and even if not killed outright it is so weakened that it becomes especially subject to the attacks of borers and other insect enemies.

The common forms both on the roots and above ground are wingless lice, not exceeding one-tenth of an inch in length, of a reddish-brown color, and abundantly covered, especially in those above ground, with a flocculent waxy secretion. (Fig. 441.)

In autumn, among the wingless ones, winged females, Fig. 440, appear in abundance. They are little, clear-winged, gnat-like objects, greenish-brown, almost black in color, with the body covered with more or less of the cottony secretion. These are the fall or return migrants that seek the elm bark to give birth to the generation of true sexes,—minute wingless, beakless creatures, the female of which deposits a single "winter egg" within a crevice of the elm bark.

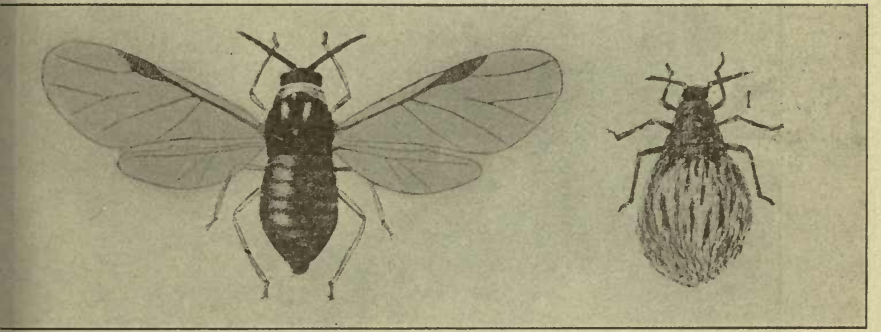

Fig. 440. Fig. 441.
Woolly Aphid. Winged and wingless forms. Greatly enlarged.
(From Marlatt.)

On the elm the stem mother, which hatches from the overwintering eggs sheltered in rough crevices of the bark, appears early in the spring and may be found in Maine before the middle of May stationed on the partly opened leaf buds.

By the last of May the earliest of these wingless stem mothers (Fig. 443) are mature and found in the leaf curl (Fig. 442) or rosette (Fig. 462, when a group of terminal leaves are affected) which they cause, producing the next generation, which are also wingless.

In the summer great numbers of winged individuals are developed. From the fact that Riley recorded 7 consecutive generations on elm and the occurence of what seems to be the elm bark feeding generations of the same species (known as *rileyi*) during the summer on tender elm bark, it would seem either that the migration from the elm leaves of these summer migrants is partly to apple bark and partly to elm bark or that elm bark colonies as well as leaf curl may be established by the first or second apterous generations. Such a life cycle is indicated in the accompanying table. This does not account for the generations resulting from the overwintering forms on the apple roots as their sequence yet remains to be studied. The fall migration of the woolly aphid from apple and the mountain ash I have observed but I have not yet from observation linked it with the true sexes on elm. That inference, however, from the evidence of the spring migration to apple is unmistakable.

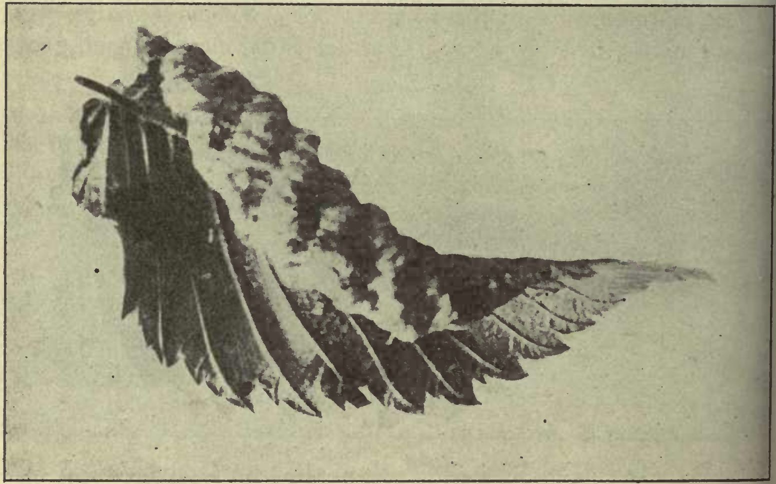

Fig. 442. Elm leaf curl, in which the alate spring migrants develop before taking flight to apple bark.

There are still several important details to be worked out for the woolly aphid of the apple and elm. Whether the elm bark colonies are originated by the stem mother, or by migrants from the leaf curl or both; whether the mid June (in Maine) winged forms from the elm bark colonies migrate to apple or scatter to other elm bark, or both; the significance of the difference in antennal types of migrants from elm leaf curl (Figs. 451, 452, 454, and 458), whether indicating locality or conditional variation; and complete sequence upon each food plant;—are subjects for further study.

These points can for the most part be watched only with colonies upon seedling stock of the food plants in confinement under such conditions that perfect control of the material can be secured. While I have further work along these lines already under way, some of the problems will need extended observations and it has seemed desirable not to wait until all tangles are straightened out before publishing the main fact of the migration test from elm leaf curl to apple bark as this point has an important bearing for young trees in nurseries and new orchards and the economic significance of the migration data will not, so far as can be anticipated, be influenced by further detailed study of the different generations.

THE SPRING MIGRATION.

The fact of the migration from elm leaf to apple and mountain ash under normal out of door conditions was established during the summer of 1912. The migrants from the elm leaves settle on the under side of the apple leaves of water shoots and there produce nymphs which seek the stem at leaf axils and there congregate in woolly masses. The mountain ashes (*Pyrus americana* and introduced species) are favorite summer hosts in Maine. From one native mountain ash at Orono more than 400 such migrants were removed July 2 to July 12 from the ventral surface of the leaves, and about 150 thriving clusters of woolly aphid nymphs, the immediate progeny of these migrants, were established on the shoots of this single tree.*

In this connection it may be of interest to record a forced migration test. On June 21, 1912, I placed several hundred elm leaf migrants at the base of water shoots of an uninfested mountain ash on the Campus. As the migrants are much more docile about sundown than earlier in the day this was done about 7 P. M. They moved but little, most of them creeping to the ventral side of a leaf and remaining there; and during the night producing nymphs which sought the leaf axils of the water shoots so that by the afternoon of June 22, the tiny nymphs had already fed enough and secreted enough white wax to give the typical "woolly" appearance to the young colonies. These and the progeny thrived on the mountain ash in a perfectly normal way.

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*A more detailed account of this occurrence is to be published in the October issue of the Journal of Economic Entomology.

SEQUENCE OF GENERATIONS. DESCRIPTIVE.

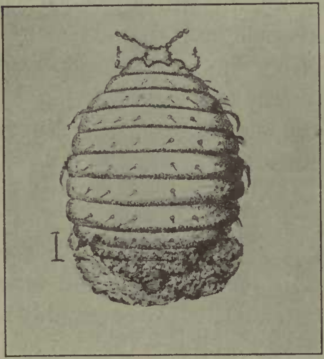

Fig. 443. Stem mother. (From Riley.)

Egg 0.5 mm. long, gamboge-yellow, inclining to brown in color, with no especial external sculpture. In crevices under elm bark.

Stem mother: Pale yellowish-red, with black members when first hatched; the red deepening and becoming purplish or livid with age. When mature, averaging 3.5 mm. in length, globose or pyriform, with subobsolete honey-tubes and six dorsal rows of darker piliferous and tuberculous spots. Antenna 5-jointed, joint 3 more than equaling 4 and 5 together in length. Causing and inhabiting elm leaf curl.

Second generation. Apterous viviparous forms which do not become so large as the stem mother. The antenna is normally 6-jointed (Fig. 461). Inhabiting leaf curl and giving birth to migrants.

Third generation. Winged viviparous female: Body dusky, the abdomen slightly reddish; legs either dusky or yellowish red. Antennæ as long as head and thorax together, dusky, rarely yellowish, not pilose, but with a few short setous points; 6-jointed. The annulation of the joints in different collections and from different localities varies greatly. Figs 451, 452, 454, and 458, cover the ordinary range. The absolute size of this generation is subject to considerable variation. These develop within and migrate from the elm leaf curl, and settling on apple produce young which inhabit apple.

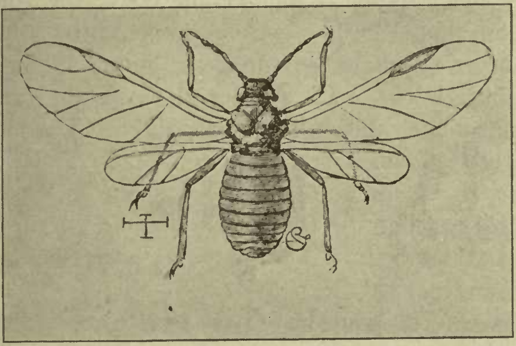

Fig. 444. Third generation. (From Riley.)

Fourth generation. That from the first winged females: Differs from the preceding in the promuscis being much longer. The antennæ have 6 joints, with no annulated constrictions. The color is sometimes decidedly orange. When newly hatched, the thickened end of the promuscis often extends one-half the length of the body beyond caudal extremity. It is born with an enveloping pellicle or pseudovum, and though of a bright red with pale legs at first soon becomes brownish, with dark members. Deposited on apple by the spring migrants and developing there in flocculent masses. Fig. 448. When mature, if the colony is crowded, some of the individuals move to a new cite on the apple bark before giving birth to the nymphs which settle near and establish thus new colonies. In other cases the nymphs themselves scatter to new cites.

Fifth generation. The second apterous generation on apple bark. Practically like the fourth generation.

Sixth? generation. From about the first of September until frost the winged fall migrants develop in the woolly colonies on apple, mountain ash, and *Crataegus* whence they migrate to elm bark to deposit their progeny, the true sexes. Figs. 455, 456, 457 and 459 give the antennæ of the fall migrant.

Together with these in the same woolly colonies develop apterous viviparous females that give birth to nymphs which seek the roots of the trees and hibernate there, surviving the winter if the conditions are favorable.

True sexual individuals: Born within an egg-like pellicle; the antennæ 5-jointed, with the joints subequal. Orange in color. Undergoing one molt, and then being at once distinguished from the other forms by the brighter orange-yellow color, the rudimentary mouth, the more simple eyes (composed of three facets), by the shorter, 5-jointed antennæ, the joints subequal in length, by the shorter legs, with smaller claws to the tarsi, and more distinct terminal capitate hairs or pulvilli. The skin is transparent, the body filled more or less with fatty globules. The female is nearly pyriform, and averages 0.4 mm. in length. A single egg is visible through the translucent skin and occupies nearly the whole of the body. The male is narrower and smaller. Figs. 446 and 447.

This generation seems to have no object in life except the deposition of eggs, since they can not eat or fly. The eggs are placed in the deepest crevices of the bark, especially those that are tangential to the tree, and are not easy to find. The small lice perish after depositing eggs leaving only the latter to survive the winter.

ECONOMIC STATUS.*

The danger from the woolly aphid is greatest to nursery stock and young orchards. Mr. Marlatt (Journal of Economic Entomology, Vol. 4. pp. 116-117) in recording the use of American-grown apple seedlings says:—"Mr. F. W. Watson, of Topeka,

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* "Mr. W. S. Griesa, proprietor of Mt. Hope Nurseries, Lawrence, Kan., has established the Griesa Research Fellowship in Entomology in memory of his father, the late A. C. Griesa. In establishing this fellowship it was the wish of the founder that the holder should devote himself to a fundamental investigation of one of the several entomological problems ever present with nurserymen.

"Upon consultation, it was decided to select for the theme of this research the Woolly Aphis. Mr. H. W. Lohrenz, A. B., McPherson College, and a graduate student at the University of Kansas, was elected by the regents of the university to this fellowship.

"The purpose of this research is, after careful experimentation in remedy and prevention, and investigation into the life cycle of this Aphis, to devise a practical means whereby nurserymen can properly deal with this economic problem in such a way as to eliminate the losses now attending the existence of this insect on nursery stock.

* * * * * * * * * * *

"It is worthy of note as showing the interest of nurserymen generally in foundations of this nature that the Western Nurserymen's Association, an organization of nurserymen of the Middle Western States, passed resolutions commending the founder of this fellowship for the work he has instituted." Journal of Economic Entomology. Vol. 4, p. 161.

Kans., in an article in the *National Nurseryman* for January, 1910, p. 437, on "American-grown Apple Seedlings," states that from twenty to forty million of American-grown apple seedlings are used in this country every year, the production of about a dozen nursery firms. The bulk of the seed used comes from France, and therefore is of the same stock as the imported French seedlings."

Mr. Lohrenz (1911) in recording observations on two-year-old nursery stock made at three nurseries containing respectively about 30,000; 45,000; and 300,000 trees, states that he found from 20 per cent to 25 per cent of the trees infested by the woolly aphid.

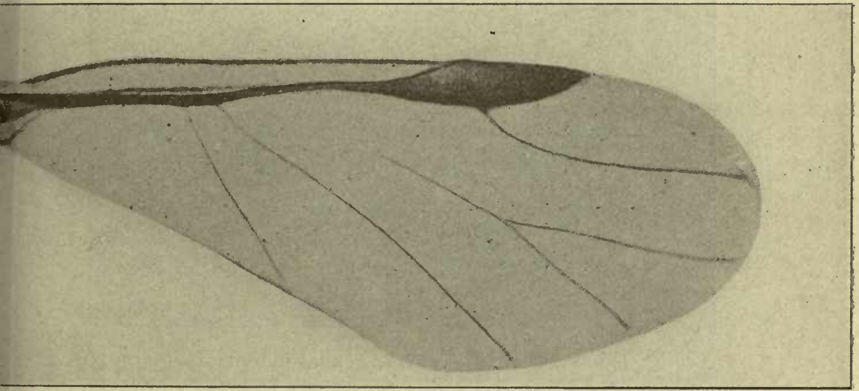

Fig. 445. Fore wing of migrant from elm leaf curl to apple. Third Generation.

In circular No. 20, Bureau of Entomology, U. S. Department of Agriculture (revised edition 1908) the woolly aphid of the apple is characterized as "one of the worst enemies of the apple."

Mr. Alwood (1904) of the Virginia State Crop Pest Commission in his excellent account of this insect states "On nursery stock the woolly aphis is a most serious pest, and under some circumstances it ruins a large percentage of the apple trees in the nursery."

On page 5 of Bulletin 133 of the Colorado Experiment Station the following statement is made:

"If Colorado orchardists should vote their opinion as to what ought to be called the worst orchard pest in the state, it is very doubtful whether the codling moth, or the woolly aphis, would carry off the honors."

Although it would be easy to compile testimony of this character against the woolly aphid as an enemy to young apple trees from numerous and widely separated parts of our country, they would be chiefly a repetition of what has already been said.

That the elm leaf curl renders the foliage of this stately tree unsightly during years of heavy infestations is well enough known in all parts of the country where the American elm is grown. Professor Gillette (Journ. Ec. Ent. Vol. 2, p. 356) states of this insect,—"This louse is a real pest upon white elm nearly everywhere that this tree is grown in Colorado."

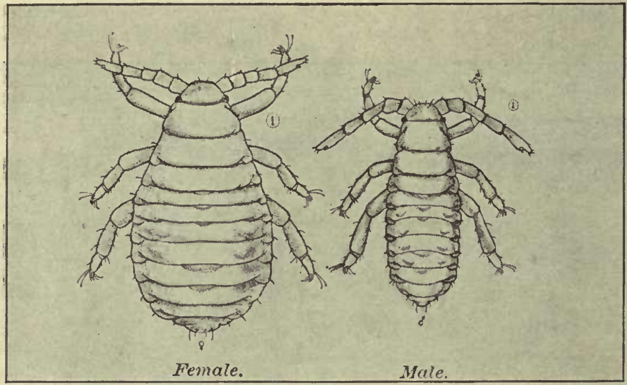

Fig. 446 and Fig. 447. Mature sexual individuals of the Woolly Aphid,—the oviparous female and male. (From Alwood.

In Montana where the white elm (*Ulmus americana*) is being established as a shade tree the insects of the elm leaf curl have taken up their abode but have found no cordial welcome for Professor Cooley says of them (Cooley 1904, p. 44).

"Altogether they are a decidedly obnoxious pest. Not only do they distinctly injure the trees but they disfigure them as well and furnish an attraction for ants, flies and other insects which visit them for the sweet liquid."

LIFE CYCLE OF WOOLLY APHID OF APPLE.

ELM: Primary Host.	APPLE: Alternate Host.
EGGS. (Under bark all winter)	NYMPHS. (From hibernating forms on roots, etc.) migrating to trunk or branches in early spring.
STEM-MOTHER. (first generation in leaf curl. Apterous viviparous females).	
SECOND GENERATION. (apterous viviparous females in leaf curl).	SEVERAL GENERATIONS.
SPRING MIGRANTS Migrate to apple . . . . . > (third generation. Alate viviparous).	
	FOURTH GENERATION. (apterous viviparous females).
SUMMER GENERATIONS ON ELM BARK.	FIFTH GENERATION. (apterous viviparous females).
Migrate to elm < . . . FALL MIGRANTS. Alate viviparous parthenogenetic females, mature Sept.-Oct. sexuparae.	APTEROUS VIVIPAROUS PARTHENOGENETIC FEMALES, mature in Sept.-Oct.
APTEROUS OVIPAROUS FEMALES AND APTEROUS MALES.	
EGGS. (under bark all winter).	HIBERNATING FORMS ON APPLE ROOT.

Preventive and Remedial Measures.

The foregoing account of the habits and characteristics of the woolly aphid will suggest certain measures to control it.

The protection of seedling apples from infestation by the woolly aphid while still in the nursery has heretofore been an exceedingly difficult matter it would seem from the amount of infested stuff that is yearly condemned. But with the knowledge that the source of danger lies in the migrants from the previously unsuspected elm curl, it is seen to be possible to control the nursery stock by establishing nurseries at a safe distance from susceptible elm trees or clearing out the elms from the vicinity of large nurseries. As there are many places in the country where the elm is not at all abundant this would often be entirely practicable and where so would be the simplest and most effective method of protection. As it is the seedling trees that are most susceptible to injury and when attacked most seriously damaged by the woolly aphid a method of protection for the young trees while in the nursery is the most desirable.

The raising of the elms and apples in the same nursery is thus seen to be a hazardous proceeding and should be avoided.

Again young orchards of clean stock set in parts of the country where the elm is not grown should be successfully protected by excluding elms from the choice of shade trees. Indeed, the matter of alternate hosts of the aphid enemies concerned should always be borne in mind in planning the trees for an estate, and only one of the two hosts necessary for the life cycle of a migratory aphid planted, where the pest is a serious one.

It is desirable that data concerning the relative susceptibility of different varieties of apple should be accumulated with a view to using the more resistant for root stock, if otherwise practicable.

In dealing with infested apple trees the aphid masses on trunk and branch present no especial difficulty, and can be very readily exterminated by the use of any of the washes recommended for plant-lice, such as tobacco decoction, kerosene emulsion, a strong soap wash (Formulas a, b, c, d), the only care necessary being to see that the wash is put on with sufficient force and thoroughness to penetrate the covering and protecting cottony secretion. If the wash be applied warm, its penetration will be considerably increased.

The much more important root feeders, however, are more difficult to reach and exterminate. The common recommendations are of applications of strong soap or tobacco washes to the soil about the crown, or soot, ashes, or tobacco dust buried about the roots; also similarly employed are lime and gas-lime.

Badly infested nursery stock should be destroyed, since it would be worth little even with the aphides removed.

Proper cultural methods can hardly be overestimated in their value as a protection of young trees, as neglected orchards not only suffer heavily but serve as a breeding ground, dangerous to the neighboring trees.

FORMULA A—TOBACCO DECOCTION.

Tobacco stems or tobacco dust..................	2 pounds
Water	4 gallons

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime or other alkaline substance should be added to the tobacco *while cooking*. Apply at once, or within a few days after making if possible.

Certain reliable extracts such as *"Black Leaf," "Black Leaf 40,"* and *"Nikoteen"* are on the market and can be secured through local druggists. (The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company*, Louisville, Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by The Nicotine Manufacturing Company, St. Louis, Mo., and can be secured from Joseph Brick & Sons, 47-54 N. Market St., Boston, Mass.).

Directions for use come with the products. There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in preparation of one gallon to sixty or sixty-five gallons of water. Careful sprayers have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of the material used.

Nikoteen is a more concentrated abstract, 1 part being used with from 400 to 600 parts of water.

Black Leaf 40 is a concentrated solution of nicotine-sulphate and is widely and successfully used in large western orchards, at the rate of 1 part to 700 or 900 parts of water.

It is the common practice to add soap,—whale oil soap or good laundry soap at the rate of 2 bars to 50 gallons. This is to lessen the formation of drops, causing the spray to cover surfaces more in the form of thin film.

Better success is obtained by some by using a little lime instead of soap, the inert solid in suspension aiding the extract to "wet" and "stick" to the bodies of the aphides. For this purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

FORMULA B.—KEROSENE EMULSION.

Hard Soap	1-2 pound
Boiling Water	1 gallon
Kerosene	2 gallons

To prepare, dissolve one-half pound of soap in one gallon of soft water by boiling; when well dissolved and still boiling hot, remove from the fire and add two gallons of kerosene, and agitate at once as briskly as possible. The emulsion is more readily made if the kerosene first be heated by immersing the vessel containing it in a larger vessel of boiling water. *Never* heat the kerosene over a direct fire.

If large quantities are being made, a good way to emulsify is to use a force pump and spraying nozzle and pump the mixture as forcefully as possible back into the vessel containing it. If the emulsion is properly formed, the whole mass will appear much like whipped cream and will mix readily in water without a film of oil rising to the top.

As soon as emulsified, add twenty-seven gallons of water and use at once. This will make thirty gallons of the mixture, and such an emulsion will be one-fifteenth oil (or a 7 per cent emulsion). This is the strength ordinarily used for the destruction of insects upon plants. For larger or smaller quantities, prepare in the same proportions.

Sometimes the emulsion is not perfect and a little oil rises to the top. In such cases, if the last in the barrel or tank is pumped out upon the foliage, it is likely to burn it. So it is advisable, unless the emulsion is of good quality, to throw out the last few gallons, making no use of it.

It is best to dilute and apply kerosene emulsion as soon as it is prepared.

Avoid using alkali or any hard water in making the emulsion, as it will cause the oil to separate and rise to the top. Any clean, soft water will usually give good results.

FORMULA C.—MISCIBLE OILS.

There are several miscible oils upon the market which may be added directly to water forming a milky emulsion at once. In the preparation of any of these, such as "Scalecide," or "Target Brand Scale Destroyer" or "Killoscale," add the oil directly to the water with a little stirring. One gallon of the miscible oil in 30 to 50 gallons of water will make a mixture, which in most cases will be strong enough to kill plant lice, if thoroughly applied.

FORMULA D.—WHALE-OIL OR FISH-OIL SOAPS.

The so-called whale-oil or fish-oil soaps which are quite extensively used for the destruction of plant lice, will usually be effective if thoroughly applied in the proportion of one pound of the soap to each six or eight gallons of water. There are numerous brands of these soaps upon the market. Among those that have been used quite successfully are Good's Whale-Oil Soap and Bowker's Tree Soap.

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In recent years tobacco extracts have rapidly taken the place of other remedies for aphides, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying.

Insect Enemies of the Woolly Aphid.

So far as the natural enemies of this pest are concerned its residence in the elm leaf curl is a vulnerable period strongly subject to attack. Very abundant in Maine working on the aphides while in the elm leaf curl are a predaceous capsid, (*Camptobrochis nitens*), flocculent larvæ of a Coccinellid and syrphus maggots. So numerous are all these insects in certain years that it has sometimes been difficult for me to secure enough of this aphid for experimental purposes,—a search through many emptied leaf curls being necessary before aphides could be found.

In other parts of the country also this aphid is preyed upon while in the elm leaf curl and frequently the only living arrivals in material sent me from other states has been the predaceous insects within the leaf curl.

Riley (1879) records as follows:—"Among the more prominent of the natural enemies of this species I have noticed, of Coleoptera, *Coccinella 9-notata, Coccinella sanguinea* (*munda*) Say, *Hippodamia convergens,* and several species of *Scymnus.* I also found feeding upon them the perfect beetle of *Podabrus modestus,* and the Hemipterous *Cyllocoris scutellatus* Uhler, and *Capsus linearis* Beauv. A Lepidopterous inquiline, namely, the larva of *Semasia prunivora* Walsh is also quite common within the curled leaves, feeding both on the lice and on the substance of the leaf. A large green *Syrphus* larva and several *Chrysopa* larvæ also prey upon them."

While on the apples the woolly aphid is subject to the attacks of a number of insect enemies, those recorded by Marlatt (1897) including "the parasitic chalcis fly, *Aphelinus mali* Haldemann, and the larva of a syrphus fly, *Pipiza radicum* Walsh and Riley, and also the larva and adult of several species of lady birds, the larvæ of lace-wing flies, and spiders, etc. In the East a very small brown species of ladybird, *Scymnus cervicalis* Muls., is often present in some numbers, and the common nine-spotted ladybird, *Coccinella 9-notata* Hbst., is also an active enemy of the woolly aphid.

"The most active natural enemies of the woolly aphis in Colorado have been predaceous insects. We have reared no parasite from it, but, Aug. 21, 1908, Mr. L. C. Bragg brought into my office a female *Aphelinus mali* busily ovipositing in apterous females of this louse. Among the Coccinellids, *Hippodamia convergens* is by far the most abundant destroyer of this louse both upon the eastern and western slopes of the mountains. Mr. E. P. Taylor also took *H. sinuata, Coccinella 9-notata, C. monticola* and *C. transversalis* feeding on this louse in the orchards about Grand Junction, and we have noted *H. transveralis, C 9-notata, C. monticola, C frigida,* and *C. 5-notata* (*transversalis* and *transversoguttata*) feeding upon it in eastern Colorado.

"Mr. Taylor also reared two syrphus flies at Grand Junction on this louse, namely, *Catabomba pyrastri* Linn, and *Eupeodes volucris* O. S.

"Lace-wing flies are also very destructive to *Schizoneura lanigera* in Colorado, and especially upon the western slope in the Grand Valley, where Mr. Taylor concluded that they did more than all else to subdue the unusually severe outbreak of this louse in that valley during the early summer of 1907. The Capsid, *Camptobrochus nebulosus* Uhl, we have found a common feeder upon this and some other plant lice in Colorado." (Gillette 1908).

FOOD PLANTS.

Crataegus Crus-galli (lucida). *Schizoneura crataegi* Oestlund. Davis, 1910, p. 412.

Crataegus punctata Jacq. *Schizoneura crataegi* Oestlund. Oestlund, 1887, p. 28. (Now considered *lanigera* by Professor Oestlund).

Crataegus tomentosus L. *Schizoneura crataegi* Oestlund. Williams, 1910, p. 20.

Crataegus sp. *Schizoneura lanigera*. Patch, 1912a, p. 236.

Pyrus malus L. *Schizoneura lanigera* Hausmann. Alwood, 1904. Gillette and Taylor, 1908, p. 28.

Pyrus sitchensis. *Schizoneura lanigera*. Patch, 1912a, p. 236. (Also on two other cultivated species of mountain ash).

Ulmus americana L. *Schizoneura americana.* Riley and *Schizoneura rileyi* Thomas (*Eriosoma ulmi* Riley). Patch, 1910a. Williams, 1910.

Ulmus campestris L. *Schizoneura ulmi* L. (*americana* Riley). Gillette, 1909, p. 356.

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Ulmus campestris L. *Schizoneura ulmi* (Linn). (*A. foliorum* De Geer) (*S. americana* Riley?) Buckton, Vol. 3, pp. 98, 100.

Ulmus sp. *Schizoneura ulmi* Linn (*fodiens* Buckton) Tullgren, 1909. p. 169.

Ribes sp. *Schizoneura ulmi* Linn. (*fodiens* Buckton) Tullgren, 1909, p. 169.

SYNONYMY AND LITERATURE.

A complete bibliography for this species is not desirable here as the accounts which throw original light upon the life history would be lost in a mass of publications compiled for economic purposes.

1802. *Aphis lanigera,* Hausmann, Beiträge zu den materialien für eine kunftige Bearbeitung der Blattlause. Illigers Magazine. T. I.
Coccus mali. Bingley (Thomas 1879, p. 126).
Eriosoma mali. (Leach MSS.) Samouelle. (Thomas, 1879, p. 126).
Myzoxylus mali. Blot. (Thomas, 1879, p. 126).

1841. *Eriosoma (Aphis) lanigera,* Harris. Report on the Insects of of Mass. injurious to vegetation, p. 193.

1841. *Schizoneura lanigera,* Hartig, Germar's Zeit. Ent. III, p. 359.

1851. *Eriosoma pyri,* Fitch. Fourth Report of the N. Y. State Cabinet of Nat. Hist., A. D. 1851, p. 68.

1856. *Pemphigus pyri.* Fitch. First Report on the Noxious, Beneficial and other Insects of the State of New York, p. 5. An account of the work upon the roots and a description of the young nymph and winged individuals, the latter evidently either with abnormal venation or an accidental migrant of a different species as this form is described with the venation of a *Pemphigus.*

1858. *Pemphigus americanus?* Walker. List of the specimens of Homopterous Insects in the collection of the British Museum.

1862. *Eriosoma (Aphis) lanigera,* Harris. Insects Injurious to Vegetation, p. 242.

1869. *Eriosoma (Pemphigus) pyri,* Riley. Insects of Missouri I, p. 118. Economic account of work on apple roots.

1869. *Eriosoma ulmi,* Riley. Insects of Missouri I, p. 123. Description of winged forms and nymphs, and account of work on elm bark.

1879. *Schizoneura americana,* Riley. Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1, pp. 4-9 and Plate I and Fig. 2. Description of seven generations on elm, with an account of the work on elm.

1879. *Schizoneura americana,* Thomas, (III), Report of the State Entomologist Ill. VIII, p. 202. Quotes Riley's description of seven generations, and concludes (p. 204): "This as admitted by Professor Riley is very closely allied to *Schizoneura ulmi,* Linn, and it is doubtful whether it should be considered as distinct."

1876-1879. *Schizoneura rileyi,* Thomas. Trans. Ill. Hort. Soc., 1876, p. 191; id. Rept. Ent. Ill. 8: 136, 137, 1879, nom. nov. for *Eriosoma ulmi* Riley. Systematic discussion and description of work. Description of insect quoted from Riley.

1879. *Schizoneura lanigera,* Thomas, III. Report of the State Entomologist Ill. VIII, p. 126. Important historical discussion.

1879. *Schizoneura ulmi,* Linn., Thomas (III) Rept. of the State. Ent. Ill., VIII, p. 140.

1885. *Schizoneura rileyi,* Forbes. Rept. Ent. Ill. 14: 114.

1887. *Schizoneura americana,* Oestlund, O. W. Aphid. Minn. p. 27. Description of winged form and pseudo gall.

1887. *Schizoneura crataegi,* Oestlund. Aphid. Minn. p. 27. Description of winged form and account of attack on *Crataegus punctata.* (Now considered to be the same as *lanigera* by Professor Oestlund.)

1888. *Schizoneura rileyi,* Lintner. 3rd Report, p. 125.

1890. *Schizoneura rileyi,* Packard. Fifth Rept. U. S. Entom. Com. Wash. Original description of insect quoted.

1890. *Schizoneura americana,* Packard. Fifth Rept. U. S. Entom. Com. p. 279. Extract from Riley Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1.

1897. *Schizoneura americana,* Gillette, C. P. Bul. Div. Ent. U. S. Dept. Agric. 9 (n. s.) : 78-79. Description of work.

1897. *Schizoneura lanigera,* Marlatt, C. L. Circ. 20, Second Ser., Div. of Ent.

1898. *Schizoneura americana,* Gillette, C. P. Bul. A. E. S. Colo. 47: 35-36. Account of work. Economic treatment. Fig. 32 photo of work.

1899. (1900). *Schizoneura americana,* Harvey. Bul. Me. Agr. Exp. Sta. No. 61. *Indem.* Ann. Rept. of Me. Agr. Exp. Sta. for 1900, p. 32. Mentioned as abundant. Photograph of leaf curl.

1900. *Schizoneura americana,* Lugger. Bul. No. 69. Minn. Agr. Exp. Sta. Id. 6th Ann. Rept. St. Ent. of the St. Exp. Sta. Univ. of Minn. pp. 168, 169. Fig. 148 after Riley.

1901. *Schizoneura americana,* Aldrich. Idaho Agric. Exp. Sta. Feby. Bul. 26, pp. 20-22. Records summer and fall (return) migration and describes true sexes. Suggests that alternate host plant may be grass.

1901. *Schizoneura rileyi,* Hunter. Aphid. of N. A., p. 84. Bibliography in part.

1902. *Schizoneura americana,* Weed, C. M. Bul. No. 90. N. H. Agr. Exp. Sta. p. 37. Brief account and photograph of curled leaf.

1902. *Schizoneura americana,* Cook, M. T. Galls and Insects Producing Them. Ohio Naturalist. Vol. II, No. 7, p. 265 and Fig. 12. Discussion of structure of gall.

1904. *Schizoneura americana,* Sanborn, C. E. Kansas Aphid. pp. 25-26, Plate VI, Fig. 37. Description of winged form and record of migration from elm.

1904. *Schizoneura lanigera,* Sanborn, C. E. Kansas Aphid. pp. 26-27. Fig. 36.

1904. *Schizoneura americana,* Cook, M. T. Galls and Insects Producing Them. The Ohio Naturalist, Vol. IV, No. 6.

1904. *Schizoneura lanigera,* Alwood, Wm. B. Circular in Relation to Some Injurious Insects and Plant Diseases. Special Bulletin (C. P. C. 45), Va. Exp. Sta. An excellent account of the insect and its work, with figures. A study of the true sexes in confinement is recorded followed by this significant statement: "We have not thus far been able to trace the migrant forms accurately, and watch the development of their young in normal situations. They behave in a very aberrant manner, and we are led to doubt the statements that their young are deposited in old colonies among the agamic forms. Definite search has not revealed them, nor have we been able to find the sexual egg in these old colonies. It is possible that there is here an unsettled problem which may have important bearing upon the distribution of the species."

1904. *Schizoneura americana,* Cooley, R. A. 10th Ann. Rept. Mont. Agr. Exp. Sta. pp. 43-45. Records this insect as a decidedly obnoxious pest in some parts of Montana on *Ulmus americana.*

1905. *Schizoneura americana,* Felt, E. P. N. Y. St. Mus. Memoir 8: pp. 172, 177-178. Description of leaf curl, and life history adapted from Riley.

1905. *Schizoneura rileyi,* Felt, E. P. N. Y. St. Mus. Memoir 8: pp. 172, 192. Brief description of work and remedies.

1907. *Schizoneura lanigera,* Smith, R. I. Bul. 23, Ga. State Board of Ent. An account after Alwood, with original photographs of work.

1908. *Schizoneura lanigera,* Gillette and Taylor. A Few Orchard Plant Lice. Bul. 133, Agr. Exp. Sta. of the Colorado Agr. College, pp. 5-23. Ecological and economic account with original figures.

1908. *Schizoneura lanigera,* Gillette, C. P. Journal of Economic Entomology, Vol. 1, pp. 306-308. Of the migrants and true sexes he writes: "We have had no trouble to get the alate females to deposit the true sexual forms in confinement. We have been utterly unable to keep these alate females upon the apple trees to deposit their young. They seem possessed of a controlling instinct to get away from the tree, so that the sexual forms have always been deposited upon the walls of the breeding cages. . . . . . Since writing the above, I have succeeded in obtaining numerous examples of light orange yellow sexual females and the smaller dusky brown males, and a few yellow eggs upon leaves and bark of twigs that had been enclosed six weeks before in small cheese cloth sacks in the orchard."

1909. *Schizoneura rileyi,* Gillette, C. P. Journal Ec. Ent. Vol. 2, p. 357. Suggests that it may be same species as *Schizoneura ulmi* (*americana*). "Of common occurrence at Fort Collins and other places in Colorado.

1909. *Schizaneura lanigera,* Gillette, C. P. Journal Ec. Ent. Vol. 2, p. 356 and Fig. 15. "This is one of the most serious and generally distributed insect pests of apple orchards in Colorado.

1909. *Schizoneura ulmi* L. (*americana* Riley) Gillette, C. P. Journal Ec. Ent. Vol. 2, p. 356 and Fig. 16. "This louse is a real pest upon white elm nearly everywhere that this tree is grown in Colorado."

1910. Davis, J. J. A List of the Aphididae of Illinois with notes on some of the species. Jour. of Ec. Ent. Vol. 3, p. 412.
Schizoneura americana. "Not infrequently injuriously abundant."
Schizoneura crataegi. "A serious pest of the hawthorns used in ornamental plantings in Chicago."

1910. *Schizoneura americana,* Patch, Edith M. Gall Aphids of the Elm. Me. Agr. Exp. Sta. Bul. 181, pp. 223-235.

1910. *Schizoneura rileyi.* Patch, Edith M. Gall Aphids of the Elm. Me. Agr. Exp. Sta. Bul. No. 181, pp. 235-238.

1910. *Schizoneura americana.* Williams, T. A. The Aphididae of Nebraska, p. 16.

1910. *Schizoneura crataegi.* Williams, T. A. The Aphididae of Nebraska, p. 19.

1910. *Schizoneura lanigera.* Williams, T. A. The Aphididae of Nebraska, p. 20. Mere mention.

1910. *Schizoneura rileyi.* Williams, T. A. The Aphididae of Nebraska, pp. 20-21. "It causes a curling of the leaves similar to *S. americana,* but the galls can be readily distinguished as those of this species are much more tightly curled than those of *S. americana.* This latter species is often to be found on the same tree. They can be easily separated, as they differ in size, antennae, venation and other minor points."

1911. *Schizoneura lanigera.* Lohrenz, H. W. Jour. Ec. Ent. Vol. 4, pp. 162-170. Ecological and economic study.

1912a. *Schizoneura lanigera.* In Bul. No. 195 Me. Agr. Exp. Sta. Recorded on *Crataegus* and three species of mountain ash.

1912b. *Schizoneura lanigera* (*americana*). Patch, Edith M. Science, Vol. 36, p. 30. Progeny of spring migrants from elm reared on apple. . . .

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If the elm species of America and Europe are the same, this insect will revert to *Schizoneura ulmi* L. (*lanigera* Hausmann) and according to European Aphidists *ulmi* migrates to the roots of currant for the summer generations where it was described by Buckton as *Schizoneura fodiens.* Are there two species in Europe known as *ulmi,* one migrating to currant and the other to apple?

1909. *Schizoneura ulmi* L. (*S. fodiens* Buckton). Tullgren. Aphidologische Studien, pp. 163-169.

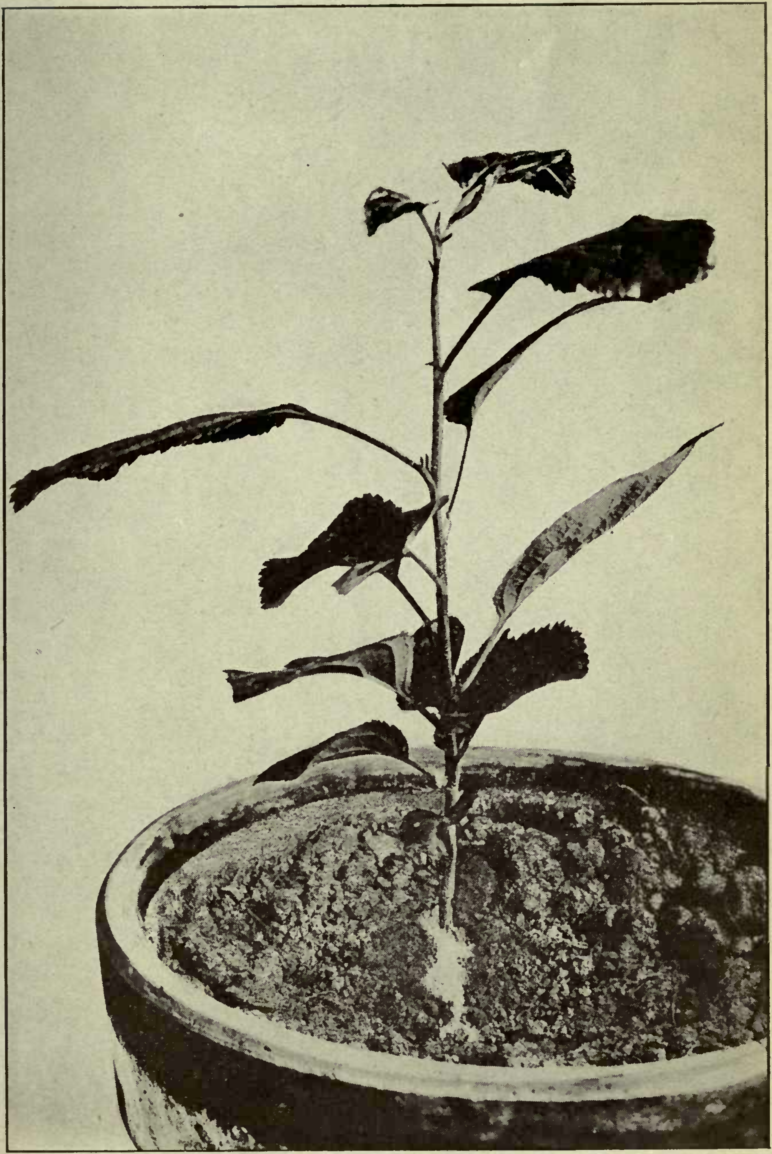

Fig. 448. Seedling apple photographed May 29, 1912, to show colony of woolly aphids which are the progeny of migrants from elm leaf curl received from the south May 12, 1912.

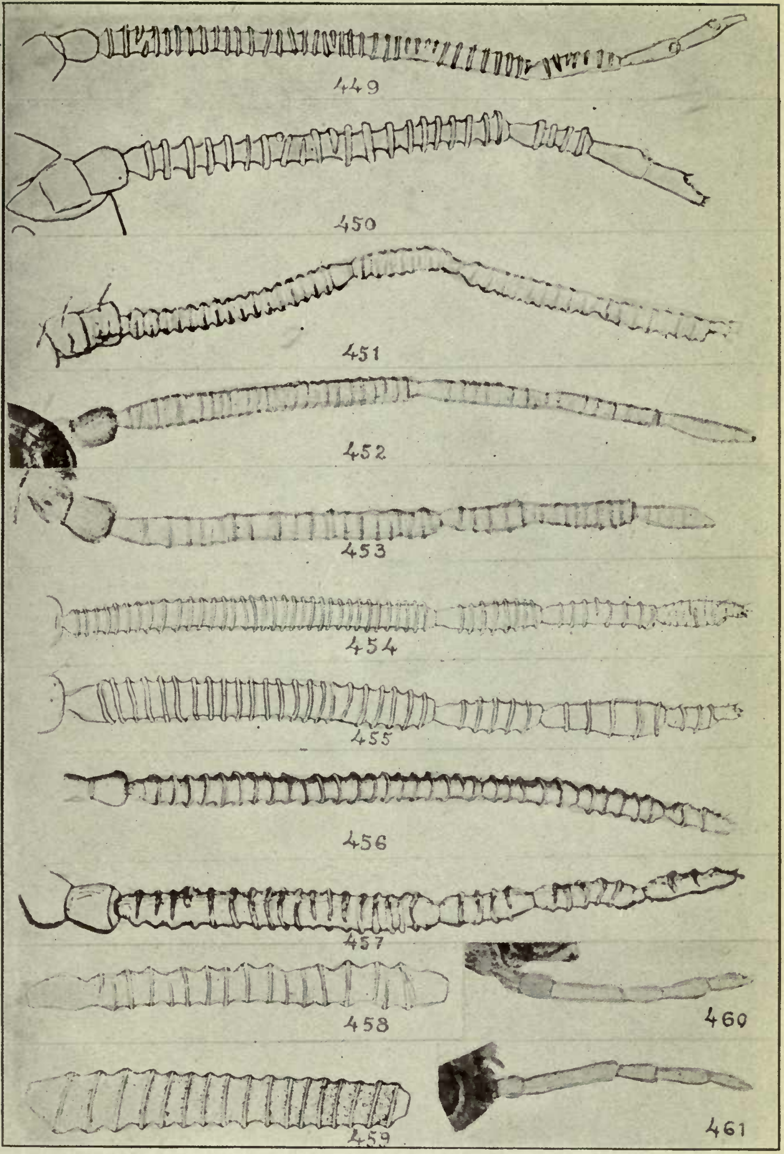

Fig. 449, *Schizoneura ulmi*. Spring migrant (Tullgren 1909). Fig. 450. *S. ulmi*. Fall migrant (Tullgren 1909). Fig. 451. *S. americana* (Riley 1879). Fig. 452. *S. americana* and Fig. 453 *S. rileyi* (Patch 1910). Fig. 454. *S. ulmi* and Fig. 455 *S. lanigera* (Gillette 1909). Fig. 456 *S. lanigera* (Alwood 1904). Fig. 457 *S. lanigera* (Marlatt 1897). Fig. 458 *S. americana* and Fig. 459 *S. lanigera* (Sanborn 1904). Fig. 460 *S. rileyi* and Fig. 461 *S. americana*, apterous viviparous forms. (Patch 1910).

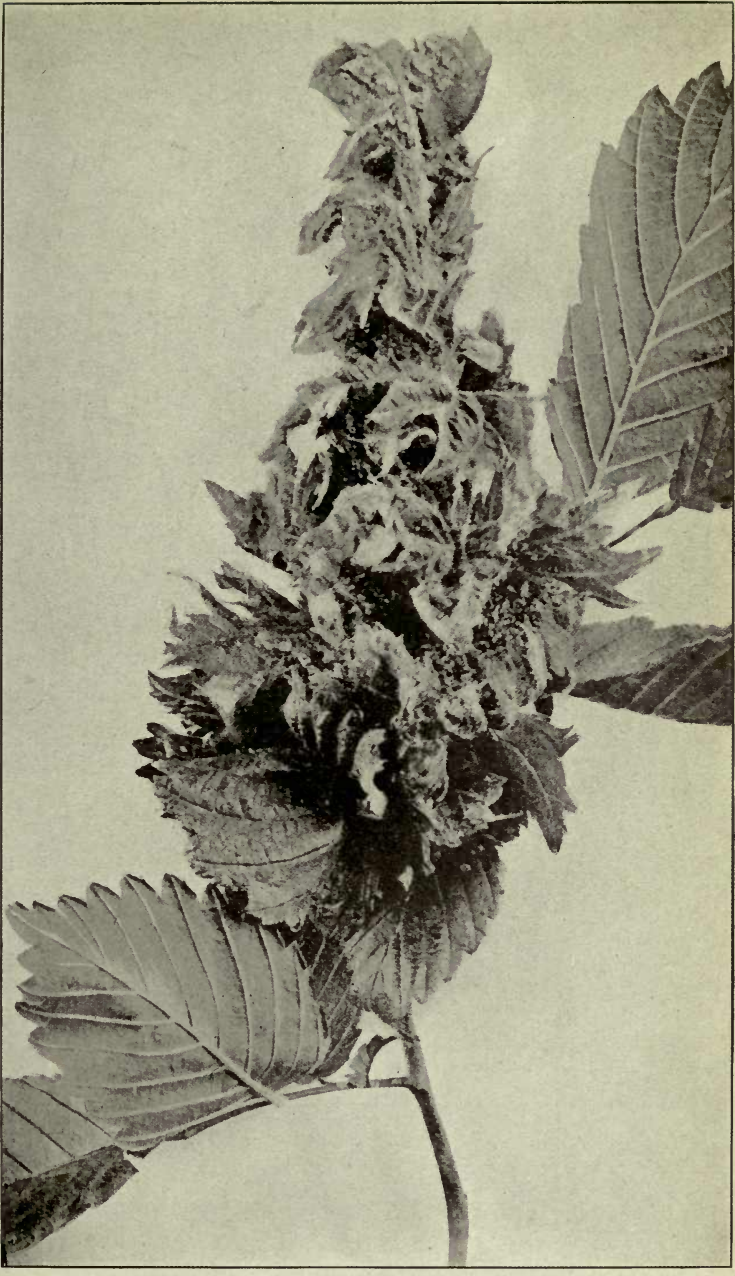

Fig. 462. Terminal leaf curl or rosette of elm leaves. The habitat of the stem mother, the second generation, and the third generation previous to their migration.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 207. **DECEMBER, 1912.**

INSECT NOTES FOR 1912

This bulletin contains notes of some of the more important insects of the year 1912, among them common scale insects, fruit and shade tree pests, wire worms in corn, and parasitic four winged flies.

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BULLETIN No. 207.

INSECT NOTES FOR 1912.*

O. A. Johannsen.

These notes are abstracts from our Station records for the present year. Though most of them deal with well known insects they are here presented because of their significance with reference to our local conditions. It is hoped that they may also contain sufficient new data upon habits and distribution to be of interest to other entomologists. In some cases descriptions, figures, and remedial measures are given so that these notes may be of service to the general reader.

The season just past has been in some ways of unusual entomological interest. The ravages of the spruce bud moth, the abundance of a spruce leaf miner and the occurrence of other spruce insects has turned much of the attention toward the conifers both native and those introduced for ornamental purposes. The increase of the gypsy moth area and the continued spread of the browntail moth have given the emphasis of one more year's experience with these two pests of paramount importance. The season has been so favorable to the development of scale insects that even those species ordinarily little noticed have been conspicuous in many parts of the State. Fortunately correlated with the abundance of injurious species the insects of 1912 have included beneficial species in great numbers. The syrphus maggots and other predaceous insects, for instance, have practically exterminated many species of plantlice over large areas, and parasites have been actively engaged in their natural welfare against the injurious caterpillars and other insects.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 61.

HOMOPTERA.

SCALE INSECTS, PLANT LICE AND OTHER BUGS.

Among the many insects which trouble the agriculturist, there is perhaps no one group which is more injurious than are the Coccidae or scale insects. In Maine there are a number of species but owing to their small size, and sombre coloring they are often passed unnoticed. The increasing practice of spraying of orchard trees by our fruit growers will tend to check the spread of species already established and prevent new ones gaining a foot hold. As the insect has sucking mouth parts and lives upon the juices of the host plants, they must be fought by means of contact sprays, such as oil emulsions, whale oil soap, or lime-sulphur. The last mentioned remedy used late in the winter as a dormant spray,* is especially recommended, for most of the species of scales mentioned in the following account.

In the preparation of these insects for examination to determine the species it is often necessary to remove them from the plant, treat them for a brief period in caustic potash, and after rinsing them in water, transfer them through several grades of alcohol, clearing in turpentine, or xylol, or other clearing fluid, and finally mounting on a glass slide in Canada balsam. Many of the scale insects are protected by a scale from which they must be removed before mounting them for examination. The scales which cover the insects in some species resemble each other so closely that the most experienced student of scale insects will not identify them without first making balsam mounts. It is therefore essential in the case of some of these species, as for example the San Jose scale, that judgment be suspended as to its identity until a thorough examination can be made.

Aspidiotus ostreaeformis.

EUROPEAN FRUIT SCALE.

Curtis, Gardiner's Chronicle III, p. 895, 1843.
Newstead, Monogr. British Coccidae. I, p. 99.
Marlatt, U. S. Dept. Agr., Div. Ent., Bul. 20, p. 81.

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* See "Apple Tree Insects of Maine," or "Apple Tree Disease," for method of preparing these sprays. These bulletins may be obtained free of charge by residents of the State upon application to the Director, Maine Agricultural Experiment Station, Orono, Maine. Both have been republished in the Report Agricultural Commissioner for 1910 under the title "Apple Tree Enemies of Maine."

Scale of female. It is circular or broadly oval in outline, dark ashy gray in color with paler margin; sometimes the scale is nearly white. The exuvia is central or nearly so, dark brown, usually naked and glossy. Diameter 1-8 of an inch.

"Adult female short ovate, almost circular, old specimens becoming chitinized; yellow or ochreous yellow. Parasitised examples broadly pyriform, inflated, usually bright orange brown, and highly chitinized. Rudimentary antennæ a mere stump with a long stiff spine at the base. Rostral filaments scarcely longer than mentum. Free abdominal segments, and margin in front with a few long hairs. Pygidium always with five groups of circumgenital glands, the anterior group consisting of from 5 to 8, the anterior laterals from 7 to 12, the posterior laterals from 5 to 16. The formula of twelve examples from a single colony on plum are given below:

5	7	5	6	5	6
8—10	9—10	8—7	7—8	9—9	6—7
8—10	9—8	5—6	10—11	11—9	12—11
6	5	5	8	6	5
11—7	9—10	7—11	8—8	12—12	9—9
8—8	8—11	16—13	12—11	11—14	11—9

"The subdorsal groups of tubular spinnerets, rather short, are connected with a double series of glands or pores. Extending from near the last marginal spine to the base of the pygidium on the dorsum is a series of, usually four, large circular pores. Vaginal opening central. Anal opening about midway between the former and the apex of the pygidium. Margin of pygidium with two pairs of lobes; median pair well developed, rounded, and notched at the sides; second pair broader than the former, but only about half the length, with the hind margin emarginate, or irregularly notched, forming a wavy outline; third pair obsolete. The first pair of plates are simple and spinelike; the second finely serrate; the first two beyond the second lobe simple or bifurcate; the third, usually, deeply and widely serrate. There are usually five long spines on either side—the first at the base of the anterior margin of the median lobes; the second and third, opposite, are attached to the base of the second lobe; the fourth and fifth considerably beyond, equidistant from the second, and somewhat longer. The body-wall is considerably thickened and chitinized at the base of the plates.

"The second-stage female possesses no ventral circumgenital glands; these organs are not developed until after the final moult.

"Perfect male varying from ochreous to pale orange yellow. Apodema black, shining. Legs dusky with long sparse hairs. Eyes and ocelli black. Abdomen gradually becoming paler towards the extremity. Antennæ of the same colour as the legs, having eight long clubbed hairs on the apical joint." *

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* Newstead, Mongr. British Coccidae I, pp. 100-102.

Life history. The winter is passed by partly grown individuals which become mature early in the summer. The insect gives birth to living young which begin to appear soon after the maturity of the female. In this State they are apparently but one brooded.

This scale has been recorded from a number of different plants, among them, the apple, pear, plum, peach, cherry, birch, poplar, horse chestnut, basswood, alder, haw, maple, aspen, oak, etc. It has been reported in this country from Maine, New York, New Jersey, Michigan, Ohio, Iowa, Idaho, California and several other states. In Maine it is most frequently found on large trees in old and neglected orchards, though we have records also of its occurrence on currant bushes. Specimens the past season were received from Brunswick, Millvale, Buckfield and W. Auburn.

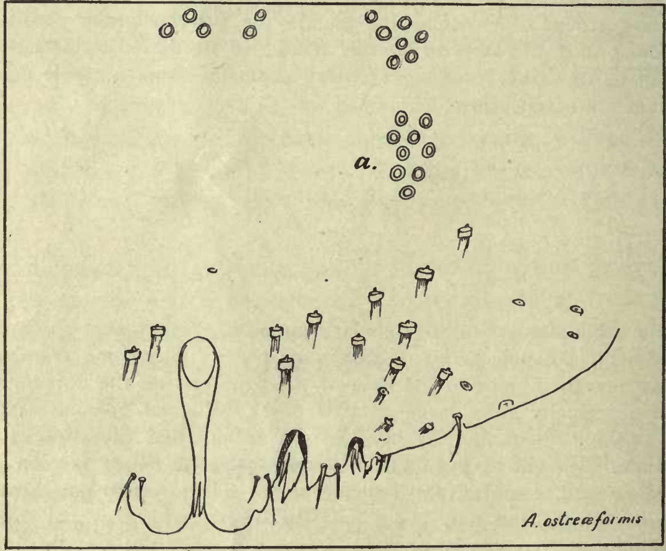

FIG. 475.

Remedies. Spraying with lime-sulphur late in the winter or early spring before the appearance of the leaves will control it.

Aspidiotus perniciosus.

SAN JOSE SCALE.

Comstock, U. S. Dept. Agr., Div. Ent. 1880, p. 304.
Herrick. Technical Bul. 2, Miss. Agr. Exp. Sta., 1911.

Scale of female. It is circular in outline, flat, with exuviae in the center surrounded by conspicuous concentric rings. Scale gray, except central part which varies from pale yellow to reddish yellow, or sometimes even black. Diameter about 1-16 of an inch.

"Female. The body is nearly circular in outline and yellowish in color. There are two pairs of lobes with the median well developed. These appear to converge, are notched once on the lateral edges, rounded at the apices, and the thickened mesal margins extend cephalad and encircle the anal opening in a conspicuous manner. The second lobes are smaller, converge toward the median, and are notched on the lateral margins. There are two thickened processes between the median lobes and two surrounding each incision, the inner the larger. There are two pectinæ between the median lobes, very inconspicuous, two pectinæ in the first incision, three pectinæ in the second incision, and three or more wide, fringed extensions of the pygidial margin laterad of the second incision. These extensions are very characteristic, in fact, are a *diagnostic character.* There is a spine on the lateral base of each lobe, one laterad of the second incision and one, one-half the distance to the penultimate segment. There are, at least, three rows of dorsal pores although they are not prominent." (Herrick).

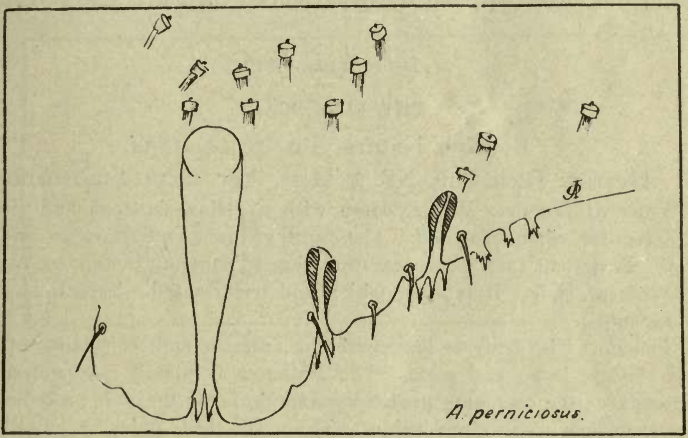

FIG. 476.

Life history. The winter is passed by this insect in a partly grown, dormant condition. On the approach of warm weather winged males and early in the summer the young appear, which are brought forth alive. In the latitude of Washington there are 4 or 5 generations, but farther north there are fewer. In parts of New York there are 3 generations. Owing to the few localities from which it has been recorded and the limited number of observations made upon this species in Maine nothing can be said in regard to the number of generations occurring during a single season. This insect occurs upon a large number of trees and shrubs in nearly every state in the Union. Specimens have been seen by the Entomologists of this Station from Limerick, West Baldwin, Wells, and Millvale.

Remedies. Spraying with lime-sulphur late in the winter or early in the spring before the appearance of the leaves will control the pest, provided the work be thoroughly done. Oil emulsions when applied by experienced men are also effective.

Aulacaspis rosae.

THE ROSE SCALE.

Bouche, Naturg. Ins. p. 14, 1834.
Herrick Tech. Bul. No. 2, Miss. Agr. Expt. Sta., 1911.

"*Scale of female.* White, often with a yellowish tinge and circular or irregular when crowded. The light yellow exuviæ are to one side of the center, in fact, quite near the edge. Diameter, 2 mm. to 3 mm.

"*Scale of male.* It is long, white, and tricarinated. Length 1.25 mm. to 1.4 mm.

"*Female.* The body is long with the anterior end, consisting of head and thorax, large and wide. The abdomen is plainly segmented with the ends of the segments projecting and those of the two preceding the last bearing 8 to 10 gland spines. There are three pairs of lobes. The median lobes are large, approximate at base but diverge laterally. They are attached to the pygidium the whole length of their lateral margins and are serrate on the inner margins. The second and third lobes are lobulated, the inner lobule always the larger. Beyond the third lobes is a double lobe-like projection marking the projection of the second pair of projecting pores. There are three pairs of conspicuous projecting pores with a single one between the median and second pairs of lobes. The plates are long and stout and situated as follows: one on the lateral base of each of the three pairs of lobes, one beyond the third pair of pores, and two usually, sometimes more, beyond the third pair of pores. There is a small seta on the median, second, and third lobes, and one just beyond the second and third pairs of pores. The dorsal pores are in three rows. The circumgenital pores were as follows in eight specimens:

15	18	12	8	16	15	17	14
24—24	21—23	23—?	31—28	27—26	25—24	24—27	22—24
20—19	24—20	27—22	25—26	21—22	23—25	26—29	21—22

"The lateral groups are often practically continuous." (Herrick 1911).

Life history. In the south this species hibernates as an immature insect but in the latitude of New Jersey and northward it winters in the egg, which hatches on the approach of spring. The species is not limited to the rose but thrives on pear, strawberry, raspberry, blackberry, etc. In this State both raspberries and blackberries are the principal sufferers. The insect has a wide distribution extending from Canada to Florida and westward to California.

Remedies. If the old raspberry or blackberry canes are regularly cleared out in the fall or spring but little trouble will be experienced from this scale.

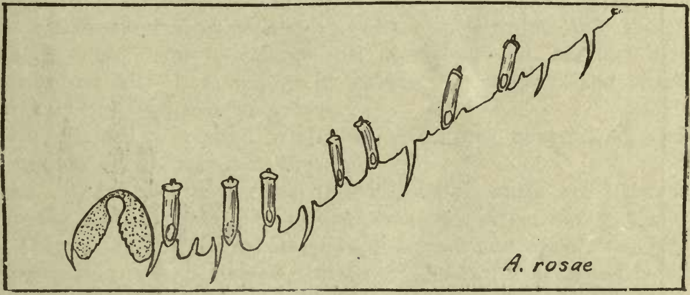

FIG. 477

Lepidosaphes ulmi.

OYSTER SHELL SCALE.

Linnaeus. Syst. Nat. Ed. X. 1, p. 455, 1758.
Herrick. Tech. Bul. No. 2, Miss. Agr. Exp. Sta., 1911.

"*Scale of female.* The scale is dark colored, long, slender, often curved and usually widest at the posterior end. It is tough, composed of concentric layers and thus resembles an oyster shell. The exuviæ are yellowish or yellowish-brown and quite prominent. 2.5 mm. to 3 mm. in length.

"*Scale of male.* It is like that of the female except smaller and the posterior part lifts up like a flap for the exit of the male when full grown.

"*Female.* The body is long and slender with the abdominal segments prominent. The median lobes are wide and prominent, stand far apart and have their edges straight and parallel. The distal ends are round and prominently notched on each side. The mesal lobules of second lobes larger. The third lobes are rudimentary. The plates are long and pointed. There are two between each pair of lobes and two pairs beyond the third lobes. There is a prominent marginal pore between median and second lobes, two laterad of the third pair of plates, two laterad of the fourth pair of plates and one laterad of the fifth pair of plates. There is a seta on each basal margin of the median lobes, one between the lobules of the second lobes, one just byond the first and second pairs of marginal pores, and one between the plates of the fifth pair. The dorsal pores are as shown in figure 478. There are five groups of circumgenital pores as follows:

9	9	11	12	
16—21	18—21	15—16	17—15	
15—13	9—11	14—15	13—12"	(Herrick 1911)

Life history. This insect has long been known in this country, though believed to be a native of Europe. In June the eggs, which are found under the scale of the old female, hatch, the active young appearing as small specks which soon attach themselves to new shoots by their beaks. The scale then begins to form gradually increasing in size. As with the San Jose scale the adult male is provided with both wings and legs.

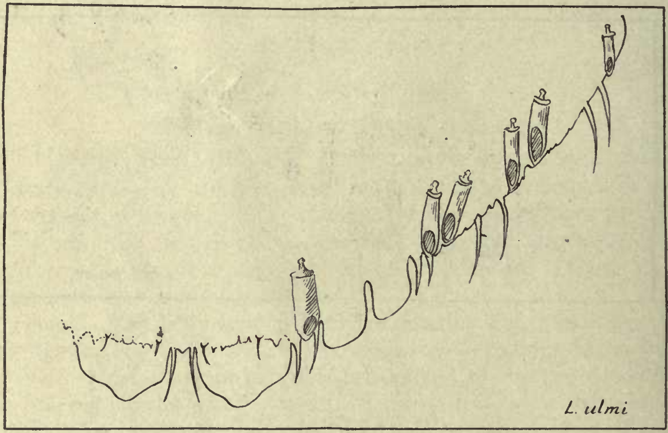

FIG. 478.

The scale occurs nearly everywhere in the United States as well as in other parts of the world, and may be found on a variety of plants. The apple, pear, plum, cherry, currant, willow, elm, birch, butternut, dogwood, ash, oak, linden, poplar, and rose being particularly affected.

It is the most common scale on the apple in Maine.

Remedies. As the insect winters in the egg stage it is quite resistant to sprays, yet experience has shown that when lime-sulphur is used in early spring for several successive seasons the scales gradually decrease in number. Oil emulsions and soap solutions are both to be recommended, when applied just after the eggs hatch, but precautions must be taken in spraying young trees with an oil emulsion to make the application in sunshiny weather lest the trees be injured.

Chionaspis furfura Fitch.

THE SCURFY SCALE.

Fitch, 3rd Report, Ins. N. Y. p. 352, 1856.
Cooley, Spec. Bul. Mass. Exp. Sta. p. 23, 1899.
Herrick. Tech. Bul. No. 2. Miss. Agr. Exp. Sta., 1911.

"*Scale of female.* Usually grayish, often snow-white, and rather irregular in shape. Apt to enlarge just beyond second exuvium and bend to right or left. It is delicate in texture, flat and thin, and broad posteriorly. Length 2.6 mm. to 3.2 mm.

"*Scale of male.* It is small, snowy-white, narrow, tricarinated, and usually straight. Length .7 mm. to 1 mm.

"*Female.* There are three pairs of lobes, all of which are striated, especially the median ones. The median lobes are large, rounded, and entire. There is an oblique bar at the base of each and often an elliptical, chitinous ring is seen at their inner mesal bases. The second lobes are divided, with the inner lobule the larger, and usually with its mesal margin more or less chitinized.

"The third lobes are also divided but are always small and often obsolete. The inner lobule, at least, is usually serrate. There is a seta on the lateral margins of the median lobes at their bases, one on the outer lobules of the second and third lobes, and one just beyond the second pair of marginal pores. The plates are as follows: 1, 1, 1, 1, 4-9. The first plate is small and may be wanting, or at least is often missing. The circumgenital pores are as follows:

12	8	8	10	9	
27—33	27—27	20—22	30—25	23—22	
25—22	25—25	16—15	23—27	17—18"	(Herrick 1911).

"*Remarks.* This species was found on apple in Mississippi and on Crataegus in Texas." (Herrick 1911).

Life history. The winter is passed in the egg underneath the scale of the female. As with the Oyster shell scale the young hatch in June and soon fix themselves by their beaks either upon the bark of the tree or upon the fruit. In the south it is stated to have 2 or 3 generations per season, but in the north there is but one generation. The species is said to occur in

Maine although no specimens have been seen by the Station Entomologists from any locality within the State. It occurs in many states in the Union as well as in New Brunswick, Ontario, Nova Scotia and Prince Edward Island, so its presence in Maine would not be surprising.

Its food plants are apple, pear, cherry, quince, crab, peach, black walnut, mountain ash, elm, currant, hawthorn, etc.

Remedies. Same as for the Oyster shell scale.

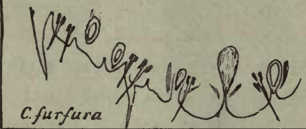

FIG. 479.

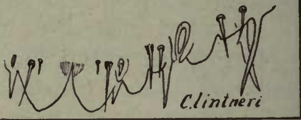

FIG. 480.

Chionaspis lintneri Comstock.

LINTNER'S SCALE. (FIGS. 480 AND 486.)

Comstock. Cornell Exp. Sta. II, p. 103, 1883.

Cooley. Special Bul. Mass. Agr. College, p. 22, 1899.

"*Scale of female.* Length 2.5-3.2 mm. (⅛ inch). Decidedly broadened posteriorly, somewhat flattened, usually thin and flexible; dull dirty white or snow-white in color. Exuviæ 1 mm. long, yellowish-brown. * * * * The second exuvia is .8 mm. long.

"*Female.* Median *lobes* obscurely pointed and faintly serrate. Second and third pairs with the inner lobule larger than the outer; faintly serrate. The *gland-spines* are long and slender and are arranged as follows: 1, 1-2, 2, 1-3, 6-9. Second row of *dorsal gland-orifices* represented by the anterior group consisting of 3-6 orifices. Third row with 4-6 orifices in the anterior and 5-7 in the posterior group. Fourth row with 6-8 orifices in the anterior and 8-10 in the posterior group. Median group of *circumgenital gland-orifices,* 11-19; anterior laterals, 25-42; posterior laterals, 19-28.

"*Scale of male.* Length .8-1 mm. Parallel-sided, distinctly tri-carinate. Exuvia yellow or almost colorless, occupying about two-fifths of the length of the scale." (Cooley 1899).

This scale has been recorded from alder, willow, birch, dogwood, shadbush. It occurs in eastern United States and Canada, having been recorded from New York, Massachusetts, Maine, Prince Edward Island, and Quebec. The species was found on the gray birch at Orono, Me., in August 1910.

Gossyparia spuria Modeer.

THE ELM SCALE. (FIG. 500.)

Modeer, Act. Goth. I, p. 43, 1778.
Felt. Ins. Affecting Park and Woodland Trees. I, 203, 1905.
Doten. Bul. No. 65. Agr. Expt. Sta. Univ. of Nevada, 1908.

This scale is frequently mentioned in literature under the name of *Gossyparia ulmi*.

"Description. The adult females are by far the most conspicuous form of this insect. They may be seen clustered along the under side of the smaller limbs, usually beside a crack or crevice in the bark, and presenting a general resemblance to a growth of lichens. The full grown, viviparous females are about 1-10 inch long just before giving birth to their young, oval in outline and with slightly pointed extremities. Each is surrounded with a white, wooly secretion, which also extends partly over the insect and thus renders its segmentation more apparent.

"The young are yellowish specks and may easily be recognized as they move over the younger limbs and leaves. They have an elongated, oval form, rounded anteriorly and tapering posteriorly to a pair of pointed processes, each bearing a long and a short seta. The body segments are marked by lateral spines and there is a row of six around the anterior border of the head and an irregular row down the middle of the back. The young soon become darker and finally assume a yellowish red color. The dorsum becomes covered with a spiny, wax secreting processes, and the general form of the young larva is retained. The antenna of the female before impregnation is composed like that of the young, of 6 subequal segments, the second and third being the longest and the fourth and fifth shortest. The antenna of the immature male has 6 nearly equal segments and a longer seventh. * * * The presence of the perfect insect within may be known by the two long, protruding anal filaments. The male is not seen without special search. It is a delicate, two winged, reddish insect with rather large antennæ, and a pair of white anal filaments nearly twice the length of its body. It moves slowly over the limbs in a clumsy way, is not easily disturbed and rarely takes wing. A most interesting feature is the occurrence of two forms. The normal one has already been described, but 10 days earlier than its occurrence there may be found large numbers of males which are characterized by the possession of wing pads but no wings. These are known as pseudimagos. The reason for the existence of two forms of males is unknown." (Felt 1905).

Life history. The winter is passed as partly grown insects which are well protected by the waxy secretions. In the spring they become active and do the most damage. The young, which are brought forth alive, make their appearance in midsummer, settling on the leaves from which they migrate at the approach of fall, to the twigs and trunk where they spend the winter. This insect has a wide distribution in the United States occurring both east and west of the Mississippi. They were very abundant in the vicinity of Orono, Maine, last year (1912) being especially conspicuous during early summer upon the trunks around the pruning wounds of the American elms.

Remedies. As for the Oyster shell scale.

Phenacoccus acericola.

MAPLE PHENACOCCUS. (FIG. 481.)

King. Canadian Entomologist. XXXIV, p. 211, 1902.

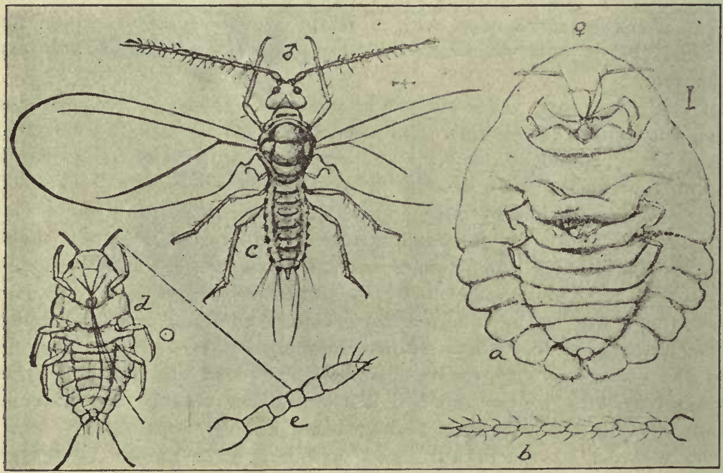

FIG. 481. *Phenacoccus acericola:*. *a*=adult female, greatly enlarged; *b*=antenna of same still more enlarged; *c*=adult male, greatly enlarged; *d*=young larva, greaty enlarged; *e*=antenna of same still more enlarged. (After Howard. Insect Life. 1894. 7 : 237).

Comstock. U. S. Dept. Agr. Rept. '80, p. 345, 1881. (*P. aceris*).
Felt. Insects Affecting Park and Woodland Trees, 182, 1905.

"Our American species when seen on the leaves appear as an irregular oval cottony mass which adheres to anything touching it and resembles very much the cottony ovisac of a *Pulvinaria*.. The cottony material is about 6 mm. in diameter and covers the insect and her eggs.

"Length of ♀ about 5 mm. long, 3 broad, plump, light yellow. Boiled in caustic potash, they turn orange red. The internal juice pressed out, the skin is colourless. The upper surface of the body is more or less covered with spinnerets and these are more dense at the posterior extremity. The margin of the body has several groups of short spines. Antennæ 9 jointed, measuring in microns.

“Joints	1.	2.	3.	4.	5.	6.	7.	8.	9.
	44.	44.	44.	30.	40.	32.	32.	28.	64.
	44.	44.	44.	32.	44.	32.	28.	28.	64.

Joint 9 is longest, 3 and 5 equal, 6 and 8 usually equal, 1 and 2 and 3 are equal and longer than any of the next five joints. The last sending in the fall, when the leaves were found on the ground, had well advanced females with their abdomen well filled with eggs, and when cleared with potash they showed only an 8 jointed antenna as follows:

“Joints (1) 40. (2) 60. (3) 48. (4) 72. (5) 40. (6) 40. (7) 28. (8) 60. Middle leg, coxa 120, femur and trochanter 240, tibia 200, tarsus 80. The legs are somewhat slender, and the claws are thin, sharp, thickened at the back, but not toothed as described by Prof. Comstock.” (King 1902).

Life history. The adult females occur on the leaves in summer, and are about 1-4 inch in length. The adults are concealed by an oval mass of powdery wax within which is the yellowish female and her eggs. The young usually remain on the leaf to feed. The males form oval cocoons under the bark of the tree. The adult females leave the leaves and wander about upon limbs or trunk and after pairing settle on the underside of the leaf, seldom crowding each other. The waxy secretion soon becomes very dense and eggs, which are very numerous, are pushed into it. In some states there may be 3 generations each year. The last generation passes the winter on the trunk.

During the early summer of 1912 a number of the maples on the Campus of the University of Maine were found to have on the trunks under the rough bark large numbers of the wax covered gravid females, the young later appearing on the leaves.

This insect has a wide distribution having been recorded in many of the northern states east of the Mississippi river. Its host plants are maple, hornbeam, lime, and horse chestnut.

Remedies. Controlled by the same methods as the Oyster shell scale.

Phenacoccus dearnessi.

King, Canadian Entomologist, XXXIII, p. 180, 1901.

“Sac white, the sac wholly covering the body. ♀ dark red-brown. Boiled in caustic potash the derm is colourless. Legs and mouth-parts ochreous. Antennæ pale yellow, 9-jointed; 3 longest, although 2 + 3 are sometimes equal, 9 next and a little longer than 1, 5 + 8 next and equal, 6 + 7 are shortest and equal. The joints are quite variable in length, as will be seen from the following measurements:

Joint	1	2	3	4	5	6	7	8	9	
	40	56	60	28	44	36	36	32	60.	Formula (39) 215 (67) 84.
	40	60	60	32	26	28	28	32	52	" (23) 915 (48) (67)
	40	52	52	40	40	28	38	32	52	" (239) (145) 8 (67)
	44	56	52	24	36	32	56	60		an 8-jointed form, hardly adult.

Legs short, stout.

Middle leg: coxa, 80; fem. with troch., 180; tibia, 116; tarsus, 72; claw, 24.

Hind leg: coxa, 88; fem. with troch., 200; tibia, 148; tarsus, 84; claw 24.

Scattered over the body are several long thin hairs and short thick spines. The gland-pits are not numerous, and are very small. Caudal tubercles, large, round, with two long setæ, and several long thin hairs; the tubercles are well covered with short, stout, spear-shaped spines. Young larva: Antennæ 6-jointed, measuring as follows: Joint—(1) 24. (2) 32. (3) 40. (4) 24. (5) 24. (6) 68." (King 1901).

Life history. The life history of this species resembles that of the foregoing. The immature insects of both sexes hibernate under the rough bark of the host plant. In the early summer the eggs are laid, the young soon migrating to the under surface of the leaves. This species has been recorded from the haw and the apple. On April 29, 1912, some twigs of the gooseberry infested with this species were received from Brunswick, Maine. The twigs were covered with the puparia of males which are small elongate, and felted, as well as a few females. On May 4 to 6 the winged male adults appeared. On the 8th of May a few females were transferred from the drying gooseberry twig to the stem of a young currant bush growing indoors. One of the females (Fig. 490) laid eggs on June 11, numerous young soon appearing and settling on the underside of the leaves. Eggs from one of the other females were later also obtained some of which were transferred to young plants of apple, elm and maple, greenhouse grown. The eggs soon hatched, the young settling upon the underside of the leaves and thriving as well as upon the original host. As the experiment was discontinued in September nothing can be said of the subsequent development. This insect has been found in a few northern states as well as in Canada.

Remedies. Same methods as for preceding species.

Eulecanium corni.

THE EUROPEAN FRUIT LECANIUM.

Bouche. Stett. Ent. Zeit. V, p. 298, 1844.
Sanders. Journal Ec. Ent. pp. 428-447, II, 1909.

The following names are all synonyms, according to Sanders: Adenostomae, armeniacum, assimile, aurantiacum, canadense, caryarum, cerasifex, coryli, corylifex, crawii, cyosbati, fitchii, fraxini, guinardi, juglandifex, kansasense, kingii, lintneri, maclurarum, mori, obtusum, pyri, rehi, ribis, robiniae, rosae, rugosum, tarsale, tibiae, vini, websteri.

"This common species which occurs on so many of our economic and wild trees and shrubs, is quite convex in form with irregular, varying rugosities and pits in the hard brown derm of the adult, or dead female. Various fuscous transverse and longitudinal markings are evident on the young adult female scale before oviposition in early summer. These markings rapidly disappear at her death and darker brown suffuses the derm, leaving sometimes a trace of fuscous on the dorsum.

"The cleared derm appears brownish, antennæ 6 or 7-segmented, usually the latter; legs well developed, ordinary; anal plates heavily chitinized, together forming nearly a square; 6 large and 2 small hairs on the anal ring; marginal spines rather short and stout 18-24 mmm. in length; spiracular spines variable, rather slender, the shorter ones 30-40mmm. and the middle one 50-60 mmm. in length. The cleared derm shows extra heavy chitinization of the regions along the anterior margin extending inward toward the antennæ, and also of the posterior lobes near the cleft. The characteristic general arrangement of the many derm pores in very irregular, broken and interrupted radiating rows, is especially noticeable near the margin. In some specimens this character is not so marked." (Sanders 1909).

This insect, if the above list of synonyms be accepted, occurs in many states on a very large number of shrubs, fruit and shade trees including the apple, plum, peach, apricot, pear, currant, blackberry, mulberry, sage, orange, elm, ash, locust, linden, maple, dogwood, etc. In Maine we have found it on elm, ash, maple, honey locust, apple, rose, and bitter sweet. Fig. 488 shows specimens of Lecanium collected on red ash, Orono, July 12.

Remedies. Thorough spraying with a crude oil or a distillate oil emulsion applied as a winter treatment. The crude oil emulsion is prepared according to the following formula. (See Bul. 80, Pt. VIII. Bur. of Ent. U. S. Dept. Agr.)

"Water	gallons	86
Fish-oil soap	pounds	10
Lye	do	2
Crude oil (16° to 22° Baume)	gallons	12

About 20 gallons of the water were heated, and when this began to boil the dissolved soap and then the lye were added. This mixture was then removed to the tank, and the rest of the water (66 gallons) added, making 86 gallons in all. The spray pump engine was then started and the crude oil slowly poured into the tank, the mixture being violently agitated by the tank agitator. A perfect emulsion resulted."

Pulvinaria vitis. (Fig. 489).

Linnaeus, Syst. Nat. I, 741, 16, 1735.

Newstead, Monog. Brit. Coccidae, II, p. 51, 1903.

Pulvinaria innumerabilis of American authors is a synonym.

"Female at period of parturition more or less cordate, narrowest in front, posterior extremity emarginate, anal cleft deep; transversely wrinkled and punctate; dorsum slightly ridged, and where the transverse wrinkles are deepest they often form conspicuous projections. Colour pale to dark chestnut-brown, with a median line of pale ochreous or brownish red. At the completion of the ovisac the extremities of the body curve upwards and inwards, the cephalic area only remaining attached to the food-plant. So much is the body wrinkled at this stage that the dermis has often the appearance of being deeply folded. After parturition the colour changes to a uniform pale or dark chestnut-brown, and the dermis is slightly shining. Antennæ normally of eight joints, but there are sometimes only seven. Formula 3, 4, 5, 2, 8, 1 (6, 7), or (3, 5), (2, 4), (6, 7), 8, 1. In all the specimens the second joint possesses a very long hair, and there is a slightly shorter one on the fifth joint, and on the terminal one are five or six. Legs ordinary; digitules to tarsus simple, those of the claw rather strongly dilated. Loop of rostrum scarcely reaching insertion of intermediate legs; mentum uniarticulate and small. Dermis with numerous ovate or approximately circular pores, and fine pentagonal tesselations, which usually disappear in boiling caustic potash. Marginal hairs small, slender, and generally curved. Stigmatic channel with minute circular spinnerets; marginal spines in a group of three, of which the centre one is much the longest and very slightly curved. Anal ring of eight hairs, enveloped, as in the genus *Lecanium,* in a thin and finely striate tube, which partly obscures the hairs of the anal ring within. Anal lobes with several fine hairs at the apex.

"The young adult female exactly resembles a *Lecanium.* Colour, under a lens, ochreous or dark yellow, rendered almost obscure by more or less confluent black spots; dorsum with a median ochreous or dull crimson band; to the naked eye the females appear dark smoky-brown in colour, with a faint olivaceous tinge, but the dorsal band is usually distinct.

"Larva with the antennæ of six joints; formula (3, 6), 2 (1, 4, 5). Legs ordinary. Anal ring with six hairs." (Newstead 1903).

Life history. The smaller twigs of maples or other trees are often covered on the underside with cottony masses which protrude from under a brownish scale. The female lays her eggs about midsummer, the young emerging from the cottony egg mass, establishing themselves along the veins on the underside of the leaves, or more rarely on the more tender twigs. In the autumn the insects migrate to the twigs before the leaves fall. The males die soon after mating; the females pass the winter on the underside of the twigs, and in the spring increase in size, secrete a large amount of honey dew which smears the leaves and everything beneath the infested trees. Later in the spring the insects begin to secrete the cottony matter in which the eggs are deposited.

The insects are found in many parts of the United States and Canada. On June 27, 1912, specimens of females with the cottony egg mases were received on maple twigs from Mr. J. W. Burke, Lee, Maine.

The host plants are maple, linden, sycamore, locust, sumac, beech, elm, oak, apple, pear, box elder, alder, hawthorn, grape, willow, and others.

Remedies. As for the Oyster shell scale.

TABLE GIVING THE DIFFERENTIAL CHARACTERS OF THE SCALE INSECTS DESCRIBED IN THE FOREGOING ACCOUNT.

a. Posterior margin of the abdomen of the female with lobed or serrate pygidium (figs. 475-480); legs wanting in the adult.
  b. Cover scale of female circular.
    c. Exuviae nearly central.
      d. With circumgenital pores (fig 475). *Aspidiotus ostreaeformis.*
      dd. Without circumgenital pores (fig 476). *Aspidiotus perniciosus.*
    cc. Exuviae nearly marginal (fig. 477). *Aulacaspis rosae.*
  bb. Female scale elongate or oval.
    c. Female scale rather narrow, often curved (fig. 478). *Lepidosaphes ulmi.*
    cc. Female scale oval, scarcely twice as long as wide.
      d. Median lobes of pygidium very broadly rounded at the extremities and set close together. (fig. 479). *Chionaspis furfura.*
      dd. Median lobes more spreading and indistinctly pointed. (Fig. 480). *Chionaspis lintneri.*

aa. Abdomen of adult female without a pygidium.
  b. No anal cleft nor triangular plates at posterior end of abdomen of female; antennæ and legs present in adult.
    c. Newly hatched nymphs with rows of dorsal spines, adult surrounded by cotton but dorsally naked. *Gossyparia spuria.*
    cc. Newly hatched nymphs without dorsal spines; antennæ 9 jointed, 6 setæ in anal ring. *Phenacoccus.*
      d. "Tibia nearly 3 times as long as the tarsi." *P. acericola.*
      dd. "Tibia less than twice as long as the tarsi." *P. dearnessi.*
  bb. Adult female with an anal cleft and triangular plates at posterior end of abdomen.
    c. Adult female is naked, more or less convex and hemispherical, scale-like, hard when mature. *Eulecanium corni.*
    cc. Secretion of female more or less cottony, ovisac posterior and adherent to twig and leaf. *Pulvinaria vitis.*

PLANT LICE.

*Aphidae.**

Among the most troublesome of the Aphides of the season were rather conspicuously those upon plum trees, currant bushes, apple trees, and elms. More detailed records of these either have been or will be given in other publications, but a few items seem to fall naturally into this bulletin.

Especial preparations had been made for migration tests with *Prociphilus venafuscus* but only a few colonies on *Fraxinus* were found this season and those were too well attended by predaceous enemies to be profitable for experimental purposes. A few colonies of this species were also found upon *Forsythia* bushes on the campus. Spring migrants were placed upon Balsam Fir seedlings in pots and in one instance a few of the progeny stationed themselves upon exposed roots and fed, normally secreting honeydew and white wax for a few days. These soon died and no conclusive data was obtained. Late in the season apterous aphides which I believe to be this species were abundant upon roots of young Balsam Firs near Orono but no pupæ were found and no developing winged forms so that again the conclusive link was lacking.

Aphis bakeri was taken on *Crataegus* in the spring and the progeny of the spring migrants responded properly to clover tests, maturing and producing there quite content. A colony of this species was brought into the Station on sweet peas.

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* Notes by Edith M. Patch.

This colony was on the stem near the ground and was only a few rods from *Crataegus* from which I had collected *bakeri* in the spring.

* * * * * * * * *

It may not be out of place at this time to add an ecological note on *Schizoneura lanigera* in the form of a problem needing further study. That is what is the fate of such winter eggs of *lanigera* as are sometimes deposited on the bark of apple? That this question is of more biological than economic interest is shown by the significant wholesale flight of the sexuparae (fall migrants) *away* from *Pyrus* which provides for the normal deposition of the true sexes and winter eggs on the true winter host with *lanigera* as is the case with other migratory aphides.

But where woolly aphid colonies are very thick, sexes and the winter eggs are sometimes found upon the apple. That such occurrences are accidental * seems not improbable but whether the emerging stem mothers of *lanigera* can develop on apple or other *Pyrus* and if so whether she is a bark feeder or whether she curls an apple leaf (as she would an elm leaf in her ordinary situation) and what the characters of her progeny are, seem to be few of the points which it would be of no slight biological interest to know.

Although I have no observations to offer on the deposition of *S. lanigera* eggs on *Pyrus,* I have been more than a little interested in accounts of such occurrences which have recently been sent me and also in the published records, the earliest of which, for this country at least, seems to be that in the Report of the Entomologist of the United States Department of Agriculture for the year 1879 by J. Henry Comstock. On page 259 of this Report Dr. L. O. Howard recorded his observations made in a little orchard of Russian apple trees then on the grounds of the

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* I have seen *Prociphilus venafuscus* fall migrants collect on both *Ulmus* and *Pyrus* sometimes in great numbers where they gave birth to true sexes and where winter eggs were deposited but so far as my observations have gone the spring stem mother develops only on *Fraxinus* and relatives (as *Lilac* and *Forsythia*) so that a deposition of the winter egg in any other situation than on the true winter host is apparently an accidental "error" on the part of the fall migrants which are responsible for the safe disposal of the true sexes on the appropriate winter host.

Department of Agriculture at Washington, his statement concerning the winter egg being as follows:—

"The winter egg was found on several occasions during the winter in crevices of the bark over which a colony had been stationed during the summer. It was a rather long ovoid, measuring .322 mm. (.125 inch) in length and was very similar to the winter egg of *Colopha ulmicola* (Fitch), as described by Riley in Bulletin No. 1, Vol. V, Hayden's Survey.

"This egg was laid, as Professor Thomas supposes, by a wingless female, differing from the ordinary agamic form to a certain extent. These females we only know from finding their skins around the winter egg, since they often die without depositing it. The males we have not seen."

An attempt was made to include in the bibliography of Bulletin 203 of the Maine Agricultural Experiment Station references to all original observations on the *Ulmus-Pyrus* Schizoneuran but other omissions besides the interesting note just quoted may have occurred in which case *addenda* from any one noticing them would be very gratefully appreciated.

LEPIDOPTERA.

BUTTERFLIES AND MOTHS.

Euvanessa antiopa.

THE YELLOW EDGE BUTTERFLY.

Specimens of the larva of this insect were perhaps more frequently received for identification by the Station this year than any other single species, as it was unusually abundant in many parts of the State. The eggs are yellow with white ridges and are attached in masses encircling the twig. Such a mass was found near the swelling leaf bud of elm, May 11 at Orono.

As a circular descriptive of this insect may be had upon application to the Station further details are here omitted.

Ctenucha virginica.

THE VIRGINIA CTENUCHA.

This beautiful little moth, with its blackish wings extending from 1 3-4 inches to 2 inches, peacock blue body and red head makes it a conspicuous object (fig. 493.) It is not uncommon in Maine, and was unusually abundant this season. The larva somewhat resembles that of the spotted tiger moth, but like other members of the family it feeds upon grasses and thus its habitat serves as a ready means of distinguishing it from the tiger caterpillars; and the characteristic hair tufts give good distinctive features if a careful examination is made. This insect hibernates in the caterpillar stage and completes its growth in the spring. On May 2 a collection of these caterpillars in their last instar was received at the Station (fig. 495). They were colored as follows: Body surface purplish black; no dorsal line present but subdorsal and lateral longitudinal line of yellowish white; head shining deep rich wine red with black face and jaws, prolegs reddish, matching head in color but not shining; true legs shining black; hair of 2nd and 3rd thoracic segments inclined down over head; hair of thorax and caudal 2 segments mixed black and white giving gray appearance; dorsal hair of abdominal segments, 1 to 8 inclusive, yellow with a row of 8 black tufts.

In confinement these caterpillars ate grass greedily, the first of them spinning a cocoon and pupating May 4-6, and the others following within a week. The cocoon is a loose oval case, composed almost entirely of the caterpillar hairs (fig. 494). The first moth emerged May 31 and the others emerged on and before June 3. Lot 1455. Hymenopterous parasites (Lot 1474) emerged from part of this lot on June 3.

Euproctis chrysorrhoea.

BROWNTAIL MOTH.

As in former seasons many nests containing larvæ of this species were received for identification by the Station during the winter of 1911-12, but unlike those received in former years, many nests contained only or chiefly dead caterpillars. What caused the death of the insects has not been satisfactorily traced to any single cause which would explain all cases and it is possible that fungous disease, insect parasites, and climatic conditions each were responsible for part of the mortality. Nests from neighboring places would in one case contain dead caterpillars and in the next a fair percentage of live ones. All of the nests from one Orono orchard were examined and found to contain practically only dead caterpillars. Parasites emerged from part of these nests.

Considering the fact that a single winter nest should contain from 150 to 350 or more hibernating larvæ the following record is of interest though it is incidental, as no attempt to canvas the State was made. Curiously the most northern nest received (Monson) contained only living caterpillars.

Partial Record of Winter Nests Received Spring 1912.

Monson, Piscataquis County. 6 nests, 700 larvæ alive.

Cooper, Washington County. 1 nest, 10 larvæ alive.

Bangor, Penobscot County. 8 nests. Most larvæ dead.

Orono, Penobscot County. Many nests (all from 1 orchard). All larvæ dead except a few and those were not vigorous.

Walpole, Lincoln County (1st sending). Many nests. Most larvæ dead.

Walpole, Lincoln County (2nd sending). Many nests. Most larvæ alive.

Auburn, Androscoggin County. 9 nests. Most larvæ dead.

Wales, Androscoggin County. 10 nests. All larvæ dead.

Oxford, Oxford County. 1 nest. 8 larvæ alive.

Freeport, Cumberland County. 4 nests. Most larvæ dead.

Brunswick, Cumberland County. Many nests. All larvæ alive.

Berwick, York County. Many nests. All larvæ alive.

Porthetria dispar.

GYPSY MOTH.

This dreaded insect pest is making its way northward in the State and the egg masses are numerous this fall in the vicinity of Portland.

TENT CATERPILLARS.

Malacosoma americana and *disstria.*

Both the Orchard Tent and Forest Tent caterpillars were unusually numerous in many parts of the State this year. Both species did much damage to the foliage of apple trees, in neglected orchards, both not infrequently being found upon the same tree. The former species constructs large tent-like web nests to which they retire when not feeding. The latter species do not make a tent but instead spin upon the trunk and larger branches of the tree they inhabit a delicate, and inconspicuous sheet of silk upon which they travel up and down. Both species deposit their eggs in the summer in a varnished mass in the form of a ring or belt about a twig. In this State they remain until they hatch the following spring. They are exceedingly abundant the present season, on one small wild cherry tree at Orono several dozen of these egg masses were seen upon a single twig.

Parasitic flies, *Tachina mella*, were bred from a number of the larvæ of both species taken in the vicinity of Orono this summer. Descriptive circulars giving remedial measures for these two species are issued by the Maine Agricultural Experiment Station.

Dioryctria abietella and *Enarmonia youngana.*

In Insect Notes for 1911 (p. 233) mention was made of injury to red spruce cones by insects. Among the insects found in the cones were the larvæ of 2 species of Tineid moths which were later reared and proved to be the above mentioned species. Lots 1303, 1386 Sub. 6.

Peronia ferrugana.

BIRCH LEAF ROLLER.

Schiffermueller, Syst. Verg. Wien. 128, 1776.
Clemens. Proc. Ent. Soc. Phil. III, 576, 1864. (P. gallicolana).

"Fore wings dull ochreous or whitish tinted with ochreous. Near the middle of the costa is a semi-oval blackish-brown spot containing blackish dots, and sometimes a whitish spot on the costa. Along the interior edge of this costal spot are a few tufts, and near the base of the fold of the wing is a single black one. The costa near the base is slightly marked with blackish and the apical portion of the wing is clouded with reddish-ochreous-reddish. Hind wings shining, rather dark gray." (Clemens).

This common European species which is also found in eastern United States, has been rather abundant in the vicinity of Orono for several seasons. The larva constructs a loose tube of silk within the rolled up edge of a gray birch leaf similar to that shown in figure 180 of Packard's Forest Insects (p. 507). In the leaf axils of the tree upon which the larvæ were found, occurred curious little tubular nests each containing a larva very similar if not identical with the above mentioned species. These tubes are constructed of silk and debris and extend down into the twig which is somewhat swelled at this point (fig. 482). Rübsaamen in the Berliner Entomologische Zeitschrift (p. 63, Vol. 33, 1889) states that this tubular nest on the Birch is the work of *P. ferrugana.* If there is no error in the identification it is probable that the larva spends its earlier life thus, and later becomes a leaf roller. As we failed to rear adults from this leaf axil inhabitant and did not observe whether the larva later left the tubes to become leaf rollers we cannot prove the identity of the two forms. Our identification of the moth was confirmed by Mr. August Busck of the National Museum. Lot. Nos. 1289, 1411, 1453.

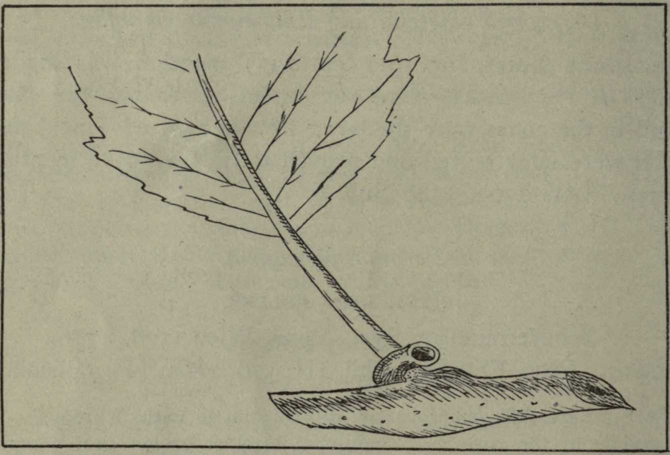

FIG. 482. *Peronia ferrugana.*

A larva forming on the alder a similar axil tube is also not uncommon at Orono, Maine. The twig is less swollen than in the case of the birch, though the projecting tube does not differ.

Olethreutes albeolana.

This species as well as an undetermined *Eucosoma* also construct tubes within the curled edge of gray birch leaves at Orono, Maine. Specimens determined by Mr. A. Busck of the National Museum. Lot 1411a.

Eulia quadrifasciana.

This species was bred from a larva found under the bark of an apple tree at Orono, Maine. Lot 1252.

Apatela funeralis.

The red headed sooty black caterpillars, each segment with transversely elliptical pale yellow mark margined with orange, were found on the Campus at Orono, Aug. 1, feeding on *Cornus stolonifera.* Lot 1553.

Tortrix fumiferana (Spruce bud moth).

Epinotia piceafoliana and *Recurvaria piceaella.*

These Tortricids were bred from larvæ found feeding upon the leaves of red and white spruces, in the spring of 1912 at Orono and elsewhere. An account of their life history will be given in a later bulletin.

HYMENOPTERA.

A PARASITE OF THE BROWNTAIL MOTH.

Monodontomerus aereus. (*Chalcidae*)

Walker, Ent. Mag. II, 158, 1834.
Mayr, Verh. Zool. bot. Ges. Wien. XXIV, p. 71, 1874.
L. O. Howard and W. F. Fiske Bul. 91, Bureau of Entomology, U. S. Dept. Agr. p. 245, 250, 1911.

"Female. Bronze, somewhat shining, quasi squamose, pubescent. Mandibles reddish fuscous; eyes and ocelli reddish; antennæ black, pubescent, first joint bronze; squamulæ reddish fuscous. Abdomen a greenish bronze, smooth, apex sparsely pubescent, not longer than the thorax, apical segment bronzy; ovipositor red, scarcely exceeding half the length of the abdomen; tegmina black, pubescent. Legs reddish fuscous, pubescent; coxæ and femora dusky greenish bronze; tarsi red, paler under the base, tip more dusky. Wings hyaline, iridescent; veins fuscous, stigma moderate in size. Length of body about 1-8 inch, wing about 3-16 inch." (Walker).

The occurrence of this parasite of the Browntail moth at Walpole, Maine, was noted in Insect Notes for 1911 (p. 243, Bul. 195, Maine Agr. Exp. Sta.). Other Maine localities from which the species has been taken either by us or by the representatives of the Bureau of Entomology, U. S. Dept. of Agriculture, are Stroudwater, Leeds Center, Bridgton, Vassalboro, Richmond, Brunswick, Freeport, Poland, Gray, Windham, Portland, Sebago, Cornish, Wells, Berwick, York, and Kittery.

This species was imported from Europe and distributed in Massachusetts about 6 years ago by the entomologists engaged in the gypsy and browntail moth investigations. Since that time the insects have gradually spread until now it has a wide distribution in northern New England. The females (figs. 483 and 499) have the habit of hibernating in the winter webs of the browntail moth, not attacking the caterpillar stage but are parasitic upon the browntail moth pupæ.

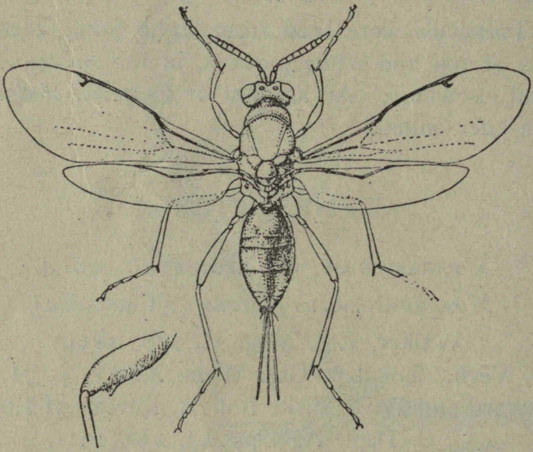

FIG. 483. *Monodontomerus aereus.* Greatly enlarged. (After Howard and Fiske, 1911).

As a period of about 2 months must elapse from the time of the escape of the parasites from the winter webs until the caterpillars of the browntail moth pupate, the little parasite must live in the open during the interval. There seems to be but one generation a year. The female deposits her eggs in the browntail moth pupæ in June, the developing young feeding internally. When mature they escape from the pupæ, the females in the fall seeking shelter in the new winter nests of the young browntail moth caterpillars.

Measures for protecting the parasite. The present method of destroying the browntail moth nests in midwinter while effective in killing the caterpillars, also destroys these parasites if present. A modification of this method could well be made by which the parasite is allowed to escape before the destruction of the nests. As heretofore the nest should be removed from the orchard or shade trees during the winter but they should be held and kept under normal outdoor conditions until the first warm days of spring when both parasites and caterpillars become active. As the parasite is the first to emerge from the nest, the nest could be destroyed as soon as the caterpillars are seen to be actively congregating on the outside. The nests as soon as cut from the tree may be placed in a barrel or other receptacle, the outside of which, at some distance from the top edge, should be smeared with a band of tree tangle foot or some similar preparation so that if the caterpillars start to creep down the side they will be checked by the sticky substance. The parasite, a small shiny black 4-winged fly, about 3-16 of an inch in length, would fly off unharmed if the tangle foot is not placed too near the upper edge. It is suggested that these barrels be placed in the vicinity of wood lots in which browntail nests are still known to exist. The parasites would thus aid in reducing the infestation in the wood lands as well as being enabled to breed and spread.

Pteromalus egregius. (*Chalcidae*)

Förster, Beitr. Monogr. Pteromal. p. 22, 1841.

L. O. Howard and W. F. Fiske. Bul. 91 Bur. Ent. U. S. Dept. Agr. 1911.

"Female. Dark green, scape at the base and the legs reddish yellow, femur dark green with yellow apex, the posterior tibiæ brown in the middle. Propodeum shining, at the base coarsely punctate, on each side with an elongate furrow; the middle transversely depressed, and with a row of deep furrows; the apex smooth, transversely aciculate. Abdomen green, with violet fasciæ. Length 1-8 inch." (Förster).

This little parasite of the browntail moth, also imported from Europe by the Entomologists of the U. S. Dept. of Agriculture about 6 years ago has been gradually spreading northward. In 1911 it was recorded by the government entomologists from Cumberland County, Maine. In March 1912, a number of specimens were obtained from winter nests which had been collected in an orchard at Orono, Maine. Fig. 484.

The females of this species also enter the web nests of the browntail moth caterpillars, but unlike the *Monodonotomerus* they oviposit upon the caterpillars after these have become dormant. The developing larvæ then feed externally upon the caterpillars, becoming full fed before cold weather sets in. Transformations are completed in the spring, the adults leaving the web nests 2 or 3 weeks after the caterpillars become active.

Protection of the parasite. The same means may be used as for *Monodonotomerus* only in this case the barrels should be left longer before destroying the webs of the browntail caterpillars.

Pteromalus puparum. (*Chalcidae*)

This little parasite was reared in large numbers from chrysalids of the yellow edge butterfly on several occasions during July 1912. From a single chrysalid collected on the campus of the University of Maine, 87 specimens emerged. Lot 1516.

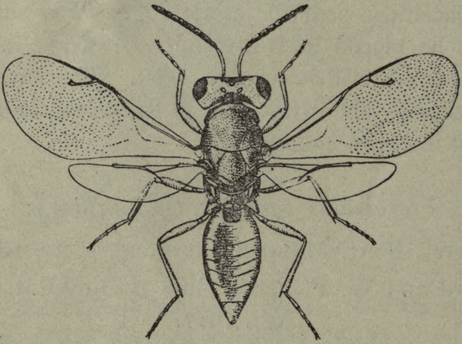

FIG. 484. *Pteromalus egregius.* Greatly enlarged. (After Howard and Fiske, 1911).

Elachertes johannseni Crawford. (*Chalcidae*)

This species mentioned in Insect Notes for 1911 (p. 243, Bul. 195 Me. Agr. Exp. Sta.) under the title of *Elachertes* sp. has recently been described by Mr. J. C. Crawford in the Proceedings of the U. S. National Museum, Vol. 43, p. 181, 1912.

Habrobracon johanseni Viereck. (*Braconidae*)

The species noted in Insect Notes for 1911 (p. 243, Bul. 195, Me. Agr. Exp. Sta.) under the name of *Bracon* sp. has recently been described by Mr. H. L. Viereck in the Proceedings of the U. S. National Museum, Vol. 42, p. 622, 1912.

ANT SWARMS.

Some male and female winged ants were received from Squirrel Island Aug. 28 with the following account by the collector. Mr. Alex Doyle.

"They invaded this island last Sunday. They seemed to come in numerous different swarms from over the water,—from the east or northeast. Each swarm was so dense as to present the appearance at a distance of 1-2 to 3-4 mile of small clouds floating across a clear sky. They drifted by my house so

floating across a clear sky. They drifted by my house so

thickly that by reaching out the hand or a cap from the piazza they could be captured, yet not one entered the piazza."

COLEOPTERA.

BEETLES.

Haltica bimarginata.

ALDER FLEA-BEETLE.

Say. Journal Phil. Ac. Nat. Sci., IV, 1824.

"*Larva.* Body somewhat flattened; head scarcely two-thirds as wide as the body in the middle; black, becoming brown in front near the jaws. Body livid brown above; the tubercles black; paler beneath; with three pairs of black jointed thoracic legs; no abdominal legs; but an anal prop-leg. The abdominal segments each with a transverse, oval-rounded, ventral, rough space forming a series of creeping tubercles, and in front on each segment is a transverse, oval, crescentic chitinous area bearing two piliferous tubercles; the back of each segment divided into two ridges, each bearing a row of six sharp tubercles, bearing short hairs; a single ventral row on each side of the ventral plate. Length 7 to 10 mm.

"*Pupa.* Body rather thick, white. Antennæ passing around the bent knees (femero-tibial joints) of the first and second pair of legs, the end scarcely going beyond the middle of the body. Elytra with five or six rather deep longitudinal creases. The salient points of the body armed with piliferous warts. Abdominal tip square at the end, with a stout black spine projecting from each side. Length, 6 mm." (Packard's Forest Insects p. 631).

"*Adult.* Oblong, subparallel. Above dark blue, moderately shining; under surface and legs blue-black, antennæ piceous. Thorax wider than long, margins very narrow, the ante-basal depression deep, reaching the sides and joining the marginal depression; surface distinctly alutaceous, sparsely punctate. Elytra wider at base than thorax, with a prominent fold extending from umbone to near apex; surface finely, rather sparsely and indistinctly punctate. Length 5-6 mm." (Blatchley's Coleoptera of Indiana).

We found this species very abundant during the past season at Orono, Castine and Monmouth, and it has also been reported from other localities. The larvæ were very numerous on the leaves of the alder (Alnus incana) during July about Orono, skeletonizing the leaves. Sometimes half a dozen larvæ were found at work upon a single leaf. The insects pupate early in August, adults appearing during the first weeks of September. The description of the larva given above, which was taken from Packard's "Forest Insects," was evidently drawn up from alcoholic specimens. In life the ground color is dark brown, or sometimes almost black, with bluish black tubercles.

WIRE WORMS IN CORN.

Agriotes mancus.

Say, Jour. Phil. Ac. Nat. Sc. III, 171, 1823.
Comstock and Slingerland. Bul. 33, Ag. Exp. Sta. Cornell
Horn. Can. Ent. Vol. 4, p. 6, 1872.
Forbes, 18th Report, 1894.

"*Larva.* The newly hatched larvæ must be very small, and, according to European writers, they grow very slowly. The smallest larvæ of the wheat wireworms we have seen were about 4 mm. in length. All variations in size occur at the same time up to a full grown larva which measures from 16 mm. to 19 mm. The larvæ are quite slender cylindrical somewhat flattened on the venter, sparsely hairy, and of a waxy yellow color, lighter at the sutures. The anal segment tapers gradually to a subacute brown point, and bears on the dorsal aspect, near the cephalic border, two large conspicuous, brown eye-like depressions resembling the breathing pores. By these, the wheat wireworm of any size may be readily separated from any other species which we have found infesting fields." (Comstock and Slingerland). Fig. 496.

"*Pupa.* "The pupa resembles the imago in many of its characters, being, however, about one-fourth longer, and in the abdominal region more slender, the only differences of moment being the following:

"Thorax at each angle with a stout bristle-like appendage more slender towards the tip, about a sixteenth of an inch long. That at the anterior angle is supported on a small papilla, the posterior being prolonged from the tip of the angle. Terminal abdominal segment above subquadrate, emarginate at tip, angles acute and divergent, beneath with deep sinuous groove on each side and a median shallower groove.

"Abdomen above and beneath of nine segments, the first very narrow, distinctly visible above, beneath visible only at the sides; second slightly broader, beneath nearly entirely concealed. The remaining segments are distinctly visible both above and beneath, the distal angles being slightly prominent, giving the sides of the abdomen a dentate appearance." (Horn 1872).

"*Imago.* Robust, color piceous to brown, elytra often paler, surface moderately pubescent. Head and thorax very convex, the mouth inferior, mandibles broad and chisel-shaped at tip; surface of head and thorax densely and coarsely punctate; striæ of elytra deep, punctate, interspaces nearly flat, rugose, and punctulate, antennæ and feet rufous.

"Length 7-9 mm." (Forbes, 1894). Fig. 498.

In Insect Notes for 1911 (p. 229, Bul. 195, Me. Agr. Exp. Sta.) there was published an account of experiments made at Highmoor Farm, Monmouth, Maine, upon wire worm extermination. Both poisons and repellants were used without avail in the field, and as a check several wire worms were placed in a small jar with some grains with which special pains were taken to coat them heavily with arsenate of lead. Several days later, some larvæ were seen, each half buried within the grain, the hull intact except for a small hole the diameter of the insect's body. A month later only the hulls of the grain remained. All the wire worms were still alive and apparently healthy. (Fig. 497.) Tobacco dust, lime and other repellants also proved ineffectual. The successful growth of Canada field peas in some of the infested plots gave the suggestion that crop rotation would be the solution of the wire worm problem and to that end potatoes, clover, beans, oats, corn, Canada field peas, and a mixture of peas and oats were sown in plots 200 feet in length, but of varying width, separated from each other by fallow areas 8 to 10 feet wide. A narrow strip plowed 6 times during the month of August 1911 was crossed at right angles by the 1912 plots. Owing to the very late spring and wet fields, the planting was unusually late. No fertilizer was put upon the field. About the middle of August the crops were inspected. Making allowance for the lateness of planting and lack of fertilizer, all the crops with the exception of the corn were in as good a condition as could be expected. The corn was rather poor though much better than on the same field the preceding season.

In preparing the field for planting half of each plot was plowed in June, the other half being only harrowed. Wire worms were abundant in the field especially about the roots of the corn plants, though apparently not as numerous as in 1911. The difficulty in conducting field experiments of this kind is the practical impossibility of having reliable checks which can be tested quantitatively, owing to the numerous uncontrollable factors. Whether the cultivation of the field during the 2 years was the cause of the apparent reduction of the wire worms or whether the weather conditions were most concerned we have no means of knowing.

There was nothing, however, in the experiments in 1912 to invalidate the conviction that continued cultivation and rotation of crops will in the course of several seasons materially reduce the wire worms in an infested field. Certain it is that sod land is always more heavily infested than fields long in cultivation. At Guilford, Maine, a place of worn out sod land newly planted to potatoes produced plants that looked at first glance like those affected with "black leg." Examination showed stems and tubers chewed by wire worms which were seen *in situ*.

A more satisfactory method of testing the food preferences of wire worms would probably be to introduce a sufficient number of larvæ of a known species into pots of the plants to be tested with suitable checks for comparison.

Most of the larvæ found at Highmoor in 1911 were *Agriotes mancus*. In 1912 over 99% of the larvæ examined belonged to this species. On August 7 while digging for larvæ several adults of this species, evidently recently transformed, as well as pupæ were found.

This species which in the middle west is known as the Wheat wire worm because of its depredations upon wheat is also a pest there to Indian corn. The adult insect probably lays her eggs near the roots of grasses and the young hatching therefrom are supposed to require 3 years to complete the life cycle. The larva transforms to the pupa late in July [illegible] early in August. The adults emerge from the ground in [illegible] or June. There is reason for believing that the [illegible] transform into adults and that they hibernate underg[illegible] form, and not as pupa.

Hylurgops (Hylesinus) opaculus.

ELM BARK BORER.

Specimens of these scolytid beetles together with a sample of their work on elm were received from Augusta, July 24, Lot 1531.

Xyleborus dispar.

APPLE TREE SHOT BORER.

Complaints of this species accompanied specimens of the beetle and examples of its work in apple bark from Rockport, Aug. 1. Lot 1551. Similar material was received Sept. 10 from Carmel. Lot 1582.

Oberea bimaculata.

CANE BORER.

Raspberries and other canes in Maine are frequently attacked by this borer which gives yearly evidence of its presence. Oviposition wounds in raspberry cane were received from East Boothbay July 17. Lot 1524. Oviposition work in blackberry and adult beetles were received from North New Portland Aug. 1. Lot 1552.

Leptura canadensis.

Specimens of this long-horned borer were received from South Paris Aug. 8, with the statement that "they have made so many holes in a piazza post of southern pine that it looks like a pepper box." Lot 1556.

Galerucella luteola.

IMPORTED ELM LEAF BEETLE.

Hibernating adult elm leaf beetles were received from Biddeford, April 20. Lot 1452. Other sendings of the adults were received from the same place May 16. Lot 1464. Larvæ were received from Eliot July 15. Lot 1515. The experience of other infested states with this imported pest seems to be in store for Maine. Much of the work on elms popularly laid to the door of *Galerucella luteola* in Maine during the past two seasons, however, was done by the larvæ of a blue *Haltica* (Bul. 195, Me. Agr. Exp. Sta. p. 233).

Saperda tridentata.

ELM-BORER.

Packard, Forest Insects, 1890, p. 224.

Forbes, Bul. 154, Univ. of Illinois Agr. Exp. Sta. 1912.

This dangerous enemy of the elm is also at work in the State and specimens were captured on the Campus July 10. Lot 1504.

Packard gives an account of this insect which reads in part:

"Perforating and loosening the bark and furrowing the surface of the wood with their irregular tracks, flat white longicorn borers, changing to beetles in June and July; the beetles flat, dark brown, with a longitudinal three-toothed red stripe on the outer edge of each wing-cover.

"This is the most destructive borer of the elm in the Northern and Eastern States, often killing the trees by the wholesale. Great numbers of the larvæ of different sizes have been found boring in the inner bark and also furrowing with their irregular tracks the surface of the wood, the latter being, as it were, tattoed with sinuous grooves, and the tree completely girdled by them in some places. The elms on Boston Common have in former years been killed by this borer, and valuable trees, we have been informed, have been killed by them in Morristown, N. J. It has been found in all stages in the elm at Detroit, Mich., by Mr. H. G. Hubbard."

Dr. S. A. Forbes in the bulletin referred to gives an account of this insect associated with "a fatal affection of the elm now prevailing over a large part of southern Illinois."

SPRAY TEST FOR CONIFERS.

It seems often desirable to recommend sprays for coniferous trees infested by aphides and there is apparently not much data as to spray injury on such trees. For this reason Mr. William C. Woods applied the sprays here indicated upon young healthy conifers at Orono as follows:

(a) Whale oil soap. One pound in two gallons of water.

(b) 69-70 Bowker's Lime-sulphur (1 part of lime-sulphur to 40 parts of water). 1-70 Nikoteen (1 part of Nikoteen to 400 parts of water).

(c) Scalecide. (1 part Pratt's Scalecide to 25 parts of water.)

On August 25, 1911, Red Spruce, White Spruce, White Pine, Balsam Fir, and Larch were sprayed with (a) and (b). On September 5, 1911, the same species of trees were sprayed with (c).

About mid July, 1912, the sprayed trees were visited and careful comparison made between these and the nearest unsprayed checks.

	(a)	(b)	(c)
Larch	No injury	No injury	No injury
Red Spruce	(Trees not located).	(Trees not located).	No injury
White Spruce	No injury	No injury	No injury
White Pine	No injury	No injury	No injury
Balsam Fir	Slight injury. Tree had grown 2 ft.	A few leaves dead. No other injury.	Tree alive. 12 branches dead. 38 branches badly injured.

The experiment was not on a large enough scale to permit any sweeping generalizations, but the results certainly indicate no especial susceptibility on the part of these conifers to injury by sprays ordinarily used on other vegetation in combating scale insects and aphides. The sprays were heavily applied until the branches were dripping and a year later all the trees were in good condition except two of the Balsam Firs and as some unsprayed Balsam Firs in the vicinity selected for checks were also in an unthrifty condition the evidence that the state of these trees was due to the spray was not at all conclusive.

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NOS. 41-59.*

41. *Insect Notes for 1909.* By O. A. Johannsen. Bulletin No. 177. Me Agr. Expt. Sta.
42. *The Fungus Gnats of North America.* Part II. By O. A. Johannsen. Bulletin No. 180. Me. Agr. Expt. Sta.
43. *Gall Aphides of the Elm.* By Edith M. Patch. Bulletin No. 181. Me. Agr. Expt. Sta.
44. *Four Rare Aphid Genera from Maine.* By Edith M. Patch. Bulletin No. 182. Me. Agr. Expt. Sta.
45. *Paedogenesis in Tanytarsus.* By O. A. Johannsen. Science, Vol. 32, p. 768.
46. *Insect Notes for 1910.* By O. A. Johannsen. Bulletin No. 187. Me. Agr. Expt. Sta.
47. *Macrosiphum destructor and Macrosiphum solanifolii.* By Edith M. Patch. Bulletin 190. Me. Agr. Expt. Sta.
48. *Insect Notes for 1911.* By O. A. Johannsen and Edith M. Patch. Bulletin No. 195. Me. Agr. Expt. Sta. 229-243.
49. *Pemphigus tessellata (acerifolii) on Alder and Maple.* By Edith M. Patch. Bulletin No. 195. Me. Agr. Expt. Sta., pp. 244-248.
50. *The Fungus Gnats of North America.* Part III. By O. A. Johannsen. Bulletin No. 196. Me. Agr. Expt. Sta.
51. *Notes on Psyllidae: Livia.* By Edith M. Patch. Psyche, Vol. 19, pp. 5-8.
52. *The Fungus Gnats of North America.* Part IV. (Conclusion) By O. A. Johannsen. Bulletin No. 200. Me. Agr. Expt. Sta.
53. *Aphid Pests of Maine.* Part I. By Edith M. Patch. Bulletin 202. Me. Agr. Expt. Sta., pp. 159-178.
54. *Food Plant Catalogue of the Aphidae of the World.* Part I. By Edith M. Patch. Bulletin No. 202. Me. Agr. Expt. Sta., pp. 179-214.
55. *Notes on Psyllidae.* By Edith M. Patch. Bulletin No. 202. Me. Agr. Expt. Sta., pp. 215-234.
56. *Elm Leaf Curl and Woolly Aphid of the Apple.* By Edith M. Patch. Science Vol. 36, pp. 30-31.
57. *A Teritiary Fungus Gnat.* By O. A. Johannsen. The American Journal of Science, Vol. 34, p. 140.
58. *Elm Leaf Curl and Woolly Apple Aphid.* By Edith M. Patch. Bulletin 203. Me. Agr. Expt. Sta.
59. *Woolly Aphid Migration from Elm to Mountain Ash.* By Edith M. Patch. Journal Economic Entomology, Vol. 5, p. 395.

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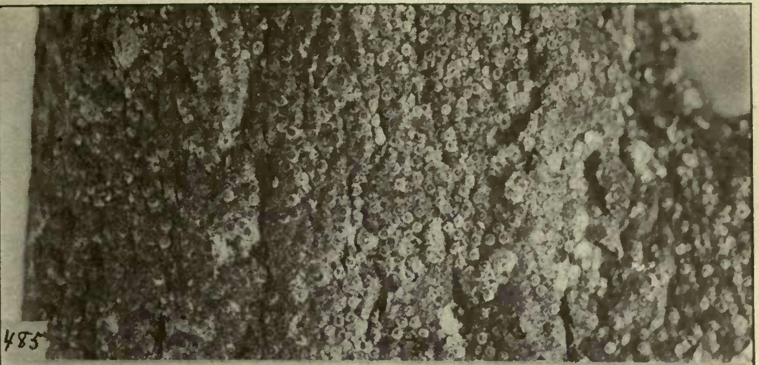
* For a detailed list of earlier publications see circular 382-5-10 of the Me. Agr. Expt. Sta.



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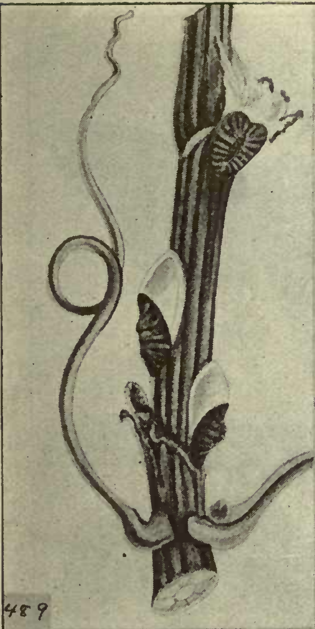

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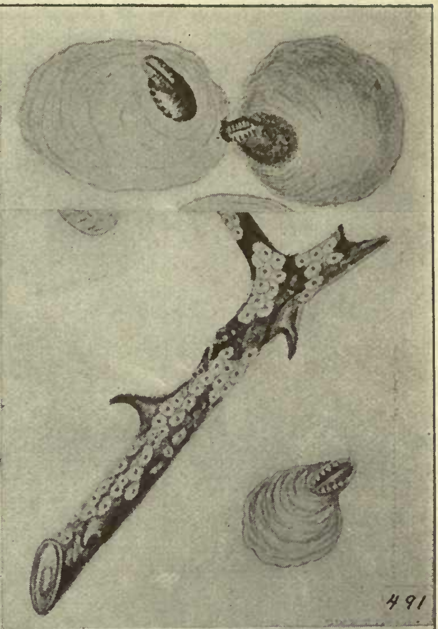

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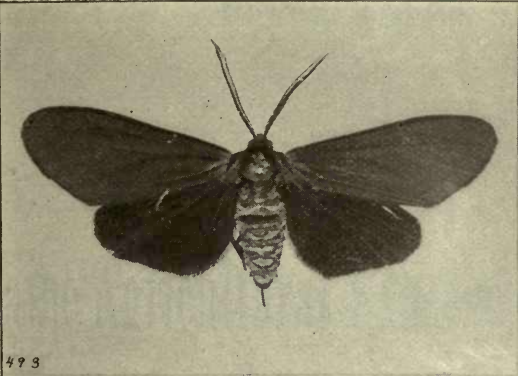
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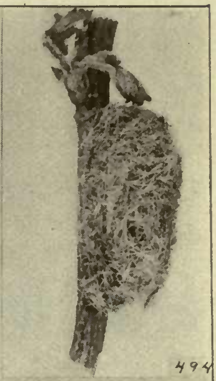
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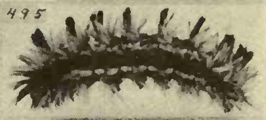
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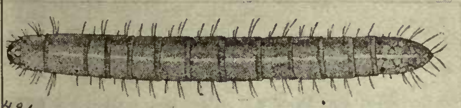
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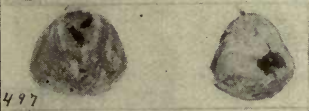
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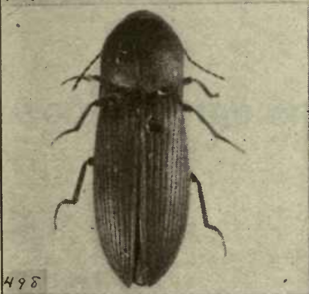
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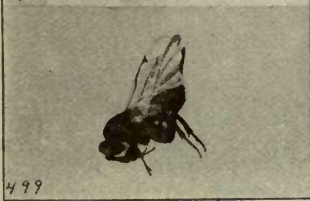
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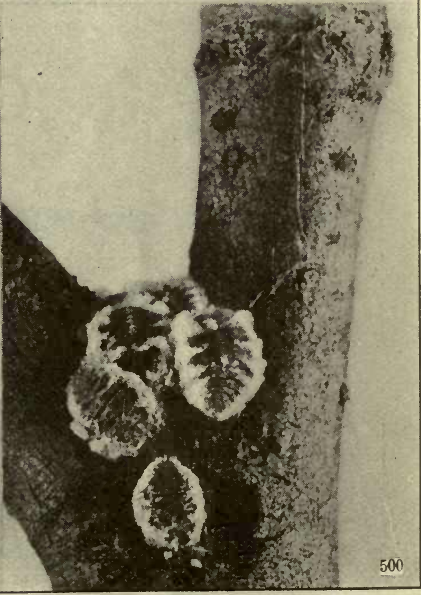
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ORONO

BULLETIN 241 **AUGUST, 1915**

WOOLLY APHID OF ELM AND JUNEBERRY

CONTENTS.

This Bulletin contains an account of the common aphid forming leaf curl of the American Elm; and records the migration of this pest to the Juneberry.

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BULLETIN 241.

WOOLLY APHID OF ELM AND JUNEBERRY.*

(*Schizoneura americana* in part, of authors.)

EDITH M. PATCH.

Each season considerable concern is expressed by residents of Maine relative to certain deformations of elm leaves due to the work of aphids. Indeed so unattractive do young elms appear when heavily infested that it sometimes seems desirable to the owners to remove them from the lawn.

Several species cause distortions of these leaves, one of which is treated in this paper in such a manner as to outline the chief points in its life cycle.

Familiar to all observers of the American Elm are leaves one edge of which is rolled under as is shown in Figure 45. Such a curl constitutes a protective habitation for a family of aphids during their spring residence there.

The mother of the colony is a large plump, somewhat powdery aphid which, if examined in the sunlight under a lens, is found to have a greenish complexion. She passes the winter in the egg stage hidden in the crevices of the elm bark. In the spring, hatching from the egg just as the leaves are unfolding, she seeks a suitable one, punctures it with her beak and by remaining and feeding causes it to curl into the protecting roll. Early in June she has attained her full growth and the leaf in which she has been dwelling looks like the left hand leaf of Figure 45. She now gives birth to a large number of young, which, unlike their mother are born alive, not undergoing any external egg stage.

Her progeny are all females which upon attaining their growth give birth in turn to living young,—also all females.

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*Papers from the Maine Agricultural Experiment Station: Entomology No. 79.

All the descendants of the original aphid or "stem-mother" as she is called, ordinarily remain in the same leaf and the curl becomes swollen and crowded with the numerous family. As each individual casts its skin several times in the process of its growth and as the discharge of honey dew is abundant, the curl after a time has a considerable amount of waste matter which causes it to look untidy within. Conditions are kept remarkably sanitary, however, by the aid of the waxy secretions of the aphids, particles of which cover the honey dew so that it rolls about in liquid pellets without drenching their bodies. These insects are further protected by the white waxy secretions which remain upon them rendering them impervious to moisture.

The earlier members of the family, including the stem-mother, are all wingless. Late in June, however, a generation matures with wings.

These winged individuals, or "spring migrants" as they are called, resemble the wingless generations previously mentioned in being all females, but they are smaller bodied and differ in various structures. Instead of remaining within the leaf with their wingless relatives these later forms take flight, seeking fresh vegetation for the establishment of the summer colonies. They are strong on the wing and fly to distances of at least three-fourths of a mile if they do not find a suitable location near at hand. When they desert the elm leaf which has furnished sap for their development they are "instinctively" led to an entirely different habitat, namely the Juneberry (*Amelanchier*) so common in Maine and variously known as Shad Bush, Service Berry, and locally as Sugar Plum.

When the migrant reaches one of these bushes it settles upon a leaf and soon afterward creeps to the underside where it remains quietly, ordinarily for the rest of its life. Before many hours it begins to give birth to young and continues this process for several days. The wee aphids, born on the underside of the Juneberry leaf, cling there for a little while without feeding and then walk down the stem of the plant. Sometimes a line of these can be seen trailing down "Indian file,"—little pellucid yellow specks so small that the observer almost requires a lens to detect them at all. The destination of these minute young is the underground stems of the Juneberry,, where they settle in groups at some tender spot.

This, then, is the destined summer residence of the insect;—the little thing whose mother, grandmother and great grandmother grew up in the curl of a high swinging elm leaf, creeps under ground and sips Juneberry sap in the dark.

There is, perhaps, no bird migration more remarkable than the flight of a migratory aphid and the histories of many species of this family of insects have the thrill of a dramatic tale of adventure.

The summer colonies of our aphid of elm and Juneberry, like their spring antecedents, are composed only of females, the first generation being wingless and the body whitened by the secretions of the wax glands.

In the fall a generation of winged females is developed among the underground forms. These are the fall migrants and in appearance they are practically like the spring migrants. These leave the Juneberry and take flight to some American Elm.

Alighting on the bark, they seek a convenient crevice and give birth to minute young, part of which are egg-laying females and part males,—this being the only time in the life cycle of this insect that either of these forms appear. These tiny "true sexes" have no functional mouth parts,—their chapter in the life history being concerned merely with mating and providing for the deposition of the overwintering egg. Each female lays but a single egg which nearly fills her small body.

The egg is the closing page of the life cycle for the fall, and the opening one for the spring; because it is from this overwintering egg that the stem-mother hatches at the time of the bursting leaf buds, in season to form the curl of the elm leaf for the spring habitation used by her and her numerous progeny.

NATURAL ENEMIES.

There are several predaceous insects which frequent the elm leaf curls of this aphid. In Maine the most common ones are a capsid (*Camptobrochis nitens*), the flocculent larva of a coccinellid, and syrphus maggots. Some years these greatly reduce the numbers of this elm pest.

PREVENTIVE AND REMEDIAL MEASURES.

In a state where both elms and Juneberries abound as they do in Maine, we must expect this aphid to occur both in the curl of the leaves of the former and on the underground stems of the latter.

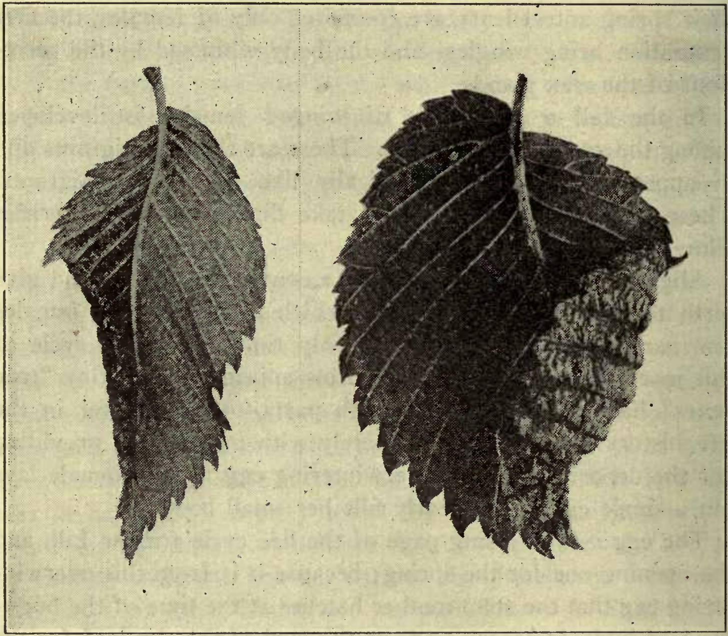

FIG. 45. Work of *S. americana* in part of authors: at left young roll containing stem female; at right, same species, old roll just deserted by migrants. Maine specimens.

Where the *Amelanchier* is planted for park or ornamental purposes within aphid flight of American Elm, it would seem desirable to try drenching the soil at the base of the shrub with Black Leaf 40 or other good tobacco decoction. Probably once about mid-July and again late in the month would be the most favorable time for this treatment as the colonies would be young and susceptible and likely to be nearer the surface than later in the season.

Young elms can be protected by spring sprays of tobacco decoction before the leaves become curled. Where large power sprayers are available old elms sprayed with drive nozzles could probably be cleaned of most of the infestation.

Dormant sprays of lime sulphur heavily coating the elm bark should be tested as to their efficiency in killing the over-wintering egg.

NOTES.

The species discussed in this paper under the title "Woolly Aphid of Elm and Juneberry" is the same species which is listed as CCC in the Habitat Key on page 184 of Bulletin No. 217 of this Station, and recorded on pages 268-271 of Bulletin No. 220.

As the alternate or summer host of this species has not previously been published, it seems desirable to state here the data upon which this life cycle is recorded.

On June 28, 1911, a collection of winged forms of this species from *Amelanchier canadensis* (L.) Medic. was made by Mr. William Woods and mounted by my assistant under the number 15-11. As *Prociphilus corrugatans* is commonly taking flight from the leaves of Juneberry late in June, I took it for granted that 15-11 was probably that species and did not examine the material until 1914 when I was startled to find that all this collection was *Schizoneura americana* of the elm leaf curl.

No additional data were obtained last year but on June 25, 1915, Mr. Woods brought into the laboratory about 30 migrants stating that they were abundant and occurring singly on the underside of the Juneberry leaves. Upon examination, I found these to be *Schizoneura americana* and as they had been collected about three-fourths of a mile from the nearest known elm, the situation was given immediate attention. I visited the place in the college woods where Mr. Woods had made his collection (50-15) and found the migrants resting upon the underside of the leaves of almost all of the numerous Juneberries in that vicinity, and did not find them settling upon other vegetation there. Upon some of the Juneberry leaves the minute yellowish young of the migrants were found, and it was an easy matter to locate on the underground stems of these shrubs, the colonies of young, already grouped about some favorable spot and covered by a slight waxy secretion.

Three young Juneberries were potted and brought into the laboratory. Migrants were removed from elm curl and caged with these plants. They settled on the ventral side of the leaves and remained there several days giving birth to their young which sought the underground stem of the accepted plant. Of course, since these plants were taken from the open, there was every possibility that their roots might have been infested also in the field. But fortunately one of the three plants was kept moist under glass and upon this the progeny of the migrants colonized on the stem well above ground where there was no danger of their being confused with field material. Some of the colony were still alive 14 days later, but they did not thrive as did the underground settlements.

On Checkerberry Hill near Orono a solitary Juneberry not more than eighteen inches high was found with several migrants on the underside of its leaves. As this plant was about three-quarters of a mile from the nearest known elm, the record is interesting.

June 28, near Orono, 415 of these migrants were counted resting on the under surface of leaves of a single large Juneberry situated between two large elms. This number was only a part of the migrants present as those on the upper leaves could not be counted from the ground.

During the week of June 27, I spent parts of several days watching some small Juneberries on the river bank ledges near Orono. The migrants from elm were present and others alighted every now and then. I saw their young trailing down the stem toward the ground, and found colonies on the underground stems here as in the college woods.

For the most part but one migrant occurred on a leaf, but where leaf curls removed from elm were placed under caged Juneberries on the ledge, as many as 16 migrants were found on the ventral surface of a single leaf. Four other kinds of plants chanced to be under the same cage and it was interesting to record that not a single migrant was found on the under surface of the leaves of any of these. One was observed walking restlessly across the top of a goldenrod leaf, but it did not remain there.

As will be seen from the date of the publication, this paper goes to press before the fall migrants are collected from Juneberry; and the statement in the life history account that the fall migration to the elm is from Juneberry is based only upon what seems to be the inevitable sequel to the behavior of the spring migrants and their progeny on the Juneberry. Knowing the summer host and that migrants seek the elm in the fall, the circumstantial evidence seems logically sufficient.

The observation here recorded open up an interesting series of questions in regard to this widely distributed elm leaf species. Does this insect occur on the elm only where that tree is within aphid flight of *Amelanchier?* If not, what summer host is accepted for such localities? Are there circumstances where the elm, alone, is able to provide for a continuation of this species? Does it occur on the roots of trees or shrubs botanically related to the Juneberry and has it in such circumstances ever been confused with *lanigera?*

In connection with the last question it might be stated that the wax gland areas of the summer root forms are different from those of *lanigera* and would doubtless serve as a sufficient means of separating

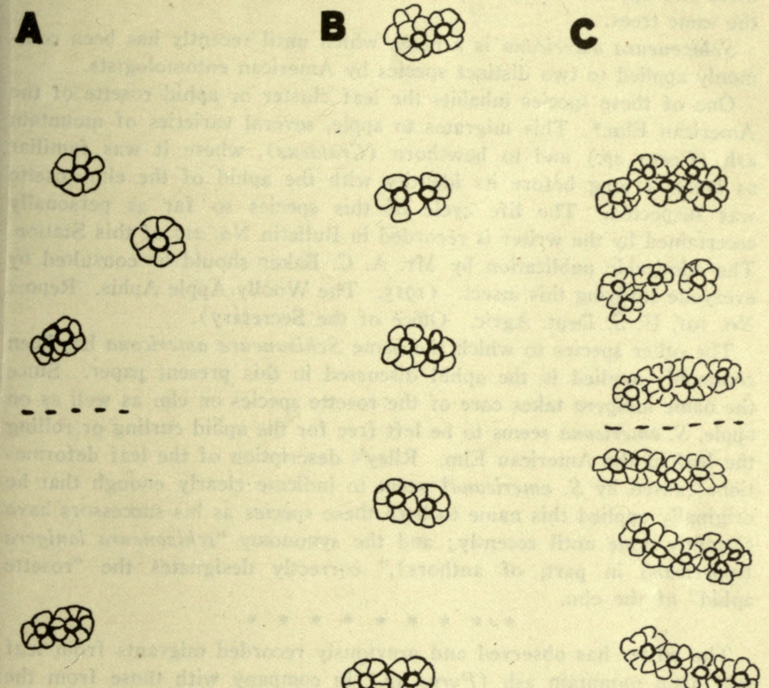

Fig. 46. Wax gland areas of nymphs of *S. americana* taken from underground stem of Juneberry, July 13, 1915. A. and B., those of one of the two dorsal lines. A, from head and thorax. B, from abdomen. C, lateral wax glands of thorax and abdomen.

these two species should they ever be found to occur upon the roots of the same trees.

Schizoneura americana is a name which until recently has been commonly applied to two distinct species by American entomologists.

One of these species inhabits the leaf cluster or aphid rosette of the American Elm.[*] This migrates to apple, several varieties of mountain ash (*Pyrus sp.*) and to hawthorn (*Crataeus*), where it was familiar as *lanigera* long before its identity with the aphid of the elm rosette was suspected. The life cycle of this species so far as personally ascertained by the writer is recorded in Bulletin No. 217 of this Station. The admirable publication by Mr. A. C. Baker should be consulted by everyone studying this insect. (1915. The Woolly Apple Aphis. Report No. 101, U. S. Dept. Agric. Office of the Secretary).

The other species to which the name *Schizoneura americana* has been commonly applied is the aphid discussed in this present paper. Since the name *lanigera* takes care of the rosette species on elm as well as on apple, *S. americana* seems to be left free for the aphid curling or rolling the leaf of the American Elm. Riley's description of the leaf deformations caused by *S. americana*[†] seem to indicate clearly enough that he originally applied this name to both these species as his successors have certainly done until recently; and the synonomy "*schizoneura lanigera* (*americana* in part, of authors)," correctly designates the "rosette aphid" of the elm.

* * * * * * * * *

The writer has observed and previously recorded migrants from leaf curl upon mountain ash (*Pyrus sp.*) in company with those from the rosette. The mountain ash concerned with that record was very near elms and whether the presence of leaf curl migrants upon that tree was accidental or whether their progeny will accept its roots as they do those of the Juneberry still remains to be ascertained.

The writer's first announcement of the migration of *lanigera* from elm to apple (Science Vol. 36, pp. 30-31) was a record of migrants from elm leaf curl establishing a successful colony upon apple seedlings. From the fact that subsequent successful migrations to apple have been from rosettes and not curls, there seems to be a possibility that rosette migrants may have been present accidentally in the curls which were collected in the South and sent to Maine, and that they were really the progenitors of the successful colony. Where curls and rosettes are present on the same tree such a mixture of the winged forms sometimes happens. Whether some southern elms support normally an elm curl form of *lanigera* or whether that initial record will stand as unique and without subsequent verification as to the type of the deformation concerned, remains to be seen.

---

[*] Figs. 70 and 71, Bulletin 217. Maine Agric. Exp. Sta.

[†] "Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf, but, according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves."

[illegible] should they ever be forced to [illegible] upon the [illegible] [illegible]

[illegible] recently has been [illegible]

One of these species [illegible] the Woolly Aphis [illegible] U. S. Dept. Agric. Office of the Secretary.

[illegible]

* * * * * * * *

The writer has obtained and [illegible] migrants from [illegible] whether the presence of [illegible] whether their progeny will accept the [illegible] those of the [illegible] will remain to be ascertained.

The writer's first [illegible] of the migration of [illegible] in the South and sent to Maine [illegible]

[illegible]

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN 253 JULY, 1916

SYRPHIDAE OF MAINE

This bulletin contains a general discussion of a group of flies which are, for the most part, not injurious, but beneficial in destroying crop-pests. Their life-stages, habits, structure and economic importance are described, and practical measures for increasing their usefulness are suggested.

A detailed summary is given on pages 193 to 197.

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†In collaboration with U. S. Department of Agriculture.

BULLETIN 253

SYRPHIDAE* OF MAINE.**

C. L. Metcalf.†

SUMMARY.

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*Pronounced Surf′-i-dee.

**Papers from the Maine Agricultural Experiment Station: Entomology 87.

†Member of the Station summer staff.

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INTRODUCTION.*

Entomologists are realizing more clearly every year the tremendous importance to agriculture and human economy of the groups of insects having the predaceous or the parasitic habit. There has long been a strong suspicion that without these natural enemies of insects man would be helpless in combating destructive crop-pests. The recent great destructiveness of certain insects introduced from foreign countries, followed by the successful repression of these pests in certain instances with their natural insect enemies (likewise introduced from foreign lands), has emphatically confirmed this opinion.

There seems to be not the slightest doubt that predaceous and parasitic insects are man's greatest ally in keeping destructive insects in control. They work without the necessity of any attention on the part of man and for the most part so unobtrusively, that most of us are unaware of their existence. It is only when some combination of conditions checks their numbers that we experience for a year or two a serious outbreak of the pests which these beneficial insects have been holding in submission and which would otherwise be seriously destructive every year.

It therefore seems desirable that we learn as much as possible about the life-histories, habits and biological relationships of such of these insects as occur in our own country. Not only because of the scientific interest which such facts may have, or so that we may learn to appreciate their value, but also in the hope that we may be able to conserve these natural resources, and possibly artificially foster, encourage, increase and transport, or extend the distribution of, the most useful ones.

One of the most universally distributed and destructive of insect groups is the Homopterous family Aphididae, or as they are commonly called, plant-lice or aphids. This group owes its success not to the hardiness or resistance of the individuals but to their remarkable fecundity, for the individual aphid is conspicuously frail, defenseless and exposed throughout its life.

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*The numbers in parentheses in the text refer to papers in the bibliography, which are serially numbered.

Because of this frailty aphids are attacked by large numbers of predators and parasites. The best known of the groups of aphid enemies are: (1) the parasitic Hymenoptera; (2) the Ladybird Beetles or Coccinellidae; (3) the Lace-winged Flies, Aphis-lions or Chrysopidae; and (4) the Flower-flies or Syrphidae. The parasitic Hymenoptera complete their transformations from eggs to minute wasps inside the body of a single aphid. The latter three groups are predaceous and grow, not at the expense of a single aphid, but by catching and eating dozens or hundreds of them. The Coccinellidae have achieved a good deal of popular interest so that there is hardly a school boy but knows that the Lady-birds eat plant-lice and are the farmers' friends. The Syrphidae, on the other hand, seem to be little known and much misunderstood by the farmer. This deplorable lack of a better popular knowledge of this group is a little hard to explain. Perhaps the principal reason is that they have been so little discussed in entomological and popular literature; and the lack of a good common name may have had its influence. Although it gives little or no intimation of the economic importance of the group, and may even be misinterpreted as indicating a habit injurious to flowers, the name "Flower-flies" seems to be the most satisfactory of the names in use; because it is based on the most characteristic habit which is uniformly true for the adults of the family: *viz,* that of visiting flowers for the purpose of getting food.

As contrasted with the Lady-birds, the movements of the Syrphid larvæ are slow, their colors subdued and their general appearance quite inconspicuous,—even repulsive. Their elongate flattened bodies are often nearly or quite covered from view by the aphids or their secretions. They are consequently usually overlooked or ignored; or the adults persecuted as "sweat-bees," under the wholly erroneous idea that they can sting; or, worse still, the flies may be accused of being responsible for the presence of the lice on the plants, or the larvæ for the damage resulting from the plant-lice.

In spite of their lack of popular recognition, I have become convinced during several years' study of this group, that, in the sections observed, the Flower-flies are a more important enemy of aphids than are the Lady-bird Beetles, and that probably they are the most important of the natural enemies of aphids. I have been gratified to find this opinion confirmed by Dr. Edith M. Patch after many years' extensive observations of the aphids of Maine.

The present bulletin deals with only one of the groups of insect enemies of aphids,—the Syrphidae. Its aim has been to elucidate the life-economy of these little-understood Flower-flies, so that the agriculturist may come to look upon them as his friends and give them his well deserved protection. And that as a basis for fostering and increasing their numbers we may have an intimate knowledge of their structure, habits and transformations. And since the larval habits are very diverse, not all being enemies of aphids and a few quite injurious, it has been deemed important to study all the species of whatever larval habit so that we may learn to distinguish the injurious and the beneficial ones.

WHAT FLOWER-FLIES ARE.

The family Syrphidae is one of a number of families comprising the great order of insects known as the Diptera, or two-winged flies, (characterized especially by the possession of a pair of knobbed threads, *halteres,* on the thorax in lieu of the second pair of wings) and to the sub-order Cyclorrhapha, section Aschiza.

They are medium to large flies, sometimes uniformly black but usually very brightly-colored; being characteristically striped, spotted or banded with bright yellow on a blue, black or metallic ground-color. The yellow occurs especially commonly as transverse bands or fasciae on the abdomen, but also on thorax and head. This black and yellow coloring gives them a general, and often a particular and very striking resemblance to wasps and hornets for which they are commonly mistaken. Other species are covered with long black and yellow hairs and resemble bumblebees. This resemblance to Hymenoptera is further heightened by their habit of visiting flowers for nectar and pollen.

The Syrphidae may be distinguished readily from all the other Diptera by the so-called *false* or *spurious vein*, which is a vein-like thickening of the wing-membrane between the third and fourth longitudinal veins (radius 4+5 and media 1+2) and running through the anterior (radio-medial) cross-vein. It can be distinguished from the true veins by the fact that it is not so clear-cut nor so deep in color and that it ends freely without joining other veins. This false vein is present in all but a very few Syrphidae and not found in the flies of any other family. In the few cases where it is wanting the fourth vein (media 1+2) terminates in the third (radius 4+5) a considerable distance from the margin of the wing. The following combination of characters will always distinguish them.*

Head at least as broad as thorax. Front never excavated, often swollen. Face excavated under the antennæ and projecting below, or with a distinct tubercle near the middle. The antennæ are three-jointed with a dorsal arista or tapering into a terminal style. Ocelli present, three. Tegulæ of moderate size. Empodia not pulvilliform. Bristles (macrochaetae) almost always wanting, never on the head. Second (radius 2+3) and third (radius 4+5) longitudinal veins never forked; fourth longitudinal vein (media 1+2) joins the third before the margin of the wing. Three posterior cells; the anal (cubital) cell long, acutely closed before the border of the wing; basal cells (radial and medial) large; *between the third* (radius 4+5) *and fourth* (media 1+2) *veins and nearly parallel with them there is a false or spurious vein* nearly always present and characteristic of the family. The post alar membranes or squamae with peculiarly-formed, forked and fan-like ciliatión, and an elongate fringed filament-like projection, the *plumula*, from the upper margin of the pteropleura beneath the squamae (Verrall).

How Flower-Flies Live.

Any one of these flies during its entire existence passes through four quite different and distinct conditions or life-stages: The egg; the larva; the pupa; and the adult.

(1) *The Egg.* The eggs of Syrphidae are placed by the parent fly in many different kinds of places, depending on the species, but generally in such a situation that the young when they hatch may easily find at hand an abundance of the par-

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*Williston (62, p. xxvi).

ticular kind of food on which they may thrive. Certain kinds, to take an example, glue their eggs to the surface of parts of plants which are infested with plant-lice or aphids. In this case they may be actually placed among the aphids or, more often, on a part of the leaf or stem within easy crawling distance of the aphids. The eggs of other species are laid upon moist filth, in the nests of other insects, in decaying wood, etc., depending on the feeding habits of the forthcoming young.

In whatever situation found, the eggs of Syrphidae have a somewhat characteristic appearance as indicated by Figs. 30-*1, 2, 3*; 31-*61, 62, 63*; 32-*41, 42, 4*; 36-*1, 2, 3*; and 37-*1, 2, 3*. They are chalk-white, shiny, elongate-ovate or subcylindrical with rounded ends. The micropylar end more truncate. Flattened slightly to the surface on which they are deposited, slightly humped above. Commonly about 1 mm. (1-25 inch) long by a third of a millimeter in diameter,—so small that they are seldom noticed yet they can easily be seen by the unaided eye. However, when viewed under a microscope the characteristic thing appears; *viz.,* a delicate and beautiful sculpturing of the shell (chorion) consisting typically of elevated oval areas (*bodies*) separated by depressed areas, but each elevation surrounded by radiating and interlacing, sometimes branched *arms,* also elevated, which they give off into the depressed areas and which often completely cover the latter with a fine elevated network.

(2). *The Larva.* Upon hatching there appears from the egg, not a miniature fly as some might expect, but a very small, slender, headless, footless, blind, creeping maggot, known technically as a *larva.* The exertions of splitting the shell and escaping from the egg may require a brief rest; but very soon the larva seeks out the food-supply. There follows a period of almost constant feeding, covering from one to several weeks, during which the maggot increases many hundreds of times in size and deposits within its body a great excess of fatty material of use in the third stage.

The larvae of the different species are by no means all similar in appearance. In fact they differ so much that no one would suspect some of them of being the young of closely-related flies. All of them agree in being eruciform, slug-like, without true legs and only the most rudimentary of pro-legs or none. They also agree in lacking a specialized head, the anterior segments being usually bluntly accuminate, and in no way constricted or marked off from the rest of the body. A few filth-inhabiting larvæ have the anterior segments globose and slightly constricted from the succeeding ones making a feebly-differentiated false-head. All the larvæ of Syrphidae carry on aerial respiration through stigmata or spiracles near the anterior and posterior ends of the body,* and lack them on the intermediate segments. *The posterior spiracles are always situated on the ends of two elongate or very short tubes which are fused mesad throughout their length, never forked or divergent,* except very slightly at the tip or in very young larvæ; and consist of three pairs of slit-like spiracles and a pair of circular plates or "buttons." The anterior larval spiracles (Fig. 33-*12;* 34-*2;* 36-*4*) are small, situated dorso-lateral near the anterior end and may be somewhat elevated on cornua or quite sessile. The head-segments bear a pair of short, fleshy, sensory structures corresponding to antennæ and certain chitinized external mouthparts. The oesophagus has also a chitinized cephalo-pharyngeal framework or skeleton. The mouth and anus are terminal or slightly ventrad at the two extremities.

The somites are not clearly differentiated and in some genera, notably *Microdon,* are indistinguishable. Usually they are indicated externally by groups of transverse wrinkles between which groups the body is slightly constricted. But more especially by the presence of a transverse row of specialized vestiture consisting typically of twelve hairs or spines either with or without subtending, conical, wart-like papillæ, called the *segmental spines or elevations* (35, p. 18). Sometimes these spines are very inconspicuous, sometimes instead of the single spine we have a clump of several soft hairs; but in all the larvæ I have examined, except the species of *Microdon,* the segmental vestiture is specialized or differentiated in some way from the other vestiture of the body, the *integumental vestiture.*

Although the segmentation is obscure in this family, for convenience of description I have assumed (35, pp. 18 and 20) that there are twelve somites represented in the larva. I have

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*I have so far failed to find anterior spiracles on the larvæ of *Microdon* which I have examined.

considered that there are two head segments cephalad of the anterior spiracles; and that these spiracles are borne on the third or prothoracic segment. On the basis of the segmental spines there are usually eight similar and sub-equal segments caudad of the one bearing the anterior spiracles, and one terminal segment which bears the posterior respiratory process, making twelve in all.

(3) *The Pupa.* When the larva is fully grown, commonly about a half inch in length, it comes to rest in some suitable place in or near the larval habitat and prepares for the transformation to the winged fly. It fastens its caudal segments to a leaf or twig or other support with glue from anal glands, or buries in the ground. Its skin inflates dorsally and laterally, nearly obscuring the wrinkles characteristic of the larva, shortens on the ventral line and becomes much indurated by the deposition of chitin, thus forming the pupa-case or *puparium.* Within this case certain complicated changes take place during which legs and wings and hair and eyes and mouth parts and the other features of a winged fly, like the one that laid the eggs, gradually make their appearance.

Since the pupa is concealed in the puparium throughout this stage, the characteristics readily observable are those of the larval skin which are, except for shape, mostly the same as during the larval period. The tracheæ leading from both anterior and posterior larval spiracles are atrophied during this stage and respiration is provided for by a pair of stigmata which pierce the puparium in the region of the fourth or fifth larval segment. From each of these stigmata a large tracheal trunk leads downward to the prothorax of the developing imago. In some species the pupal respiratory stigmata are much elevated on cylindrical cornua (Figs. 36-*8A*; 37-*6A*); in others they are sessile, exceedingly small and often indistinguishable or apparently wanting (Fig. 30-*7A*). The characteristics of the larval skin, such as anterior and posterior larval spiracles, prolegs and vestiture, usually remain practically unchanged throughout this period.

The coarctate pupa (Fig. 32-*53*, *54*) is protected by the hard puparium and, within this, a thin, delicate, transparent membrane (Fig. 32-*54a*) encases the developing wings, legs, and other parts of the body. The segmentation and appendages of the fly are produced very gradually. The legs, mouth-parts and wing-pads differentiate first while the dorsal part of the body and especially the abdomen is still eruciform as in the larva. Antennæ and eyes next take form followed by the segmentation of the abdomen the appearance of the vestiture and the differentiation of the thorax. The hind leg during this stage is bent at the middle of the tibia at an angle of about 150 degrees. The coloration of the adult is well developed sometimes several days before emergence; and in species where the puparium is quite transparent it is often possible to identify the species through the puparium.

(4) *The Adult.* When fully formed the adult pushes off a lid-like portion of the anterior end of the puparium by the dilation of its face and crawls out of the opening so formed. Emergence often requires several hours' time and not infrequently a specimen dies in the attempt to disentangle itself from the puparium. By the time emergence is accomplished the insect has practically assumed the adult form. The principal difference is that the wings are thick, crumpled and folded (Fig. 32-54) and must expand to a much greater area, become flattened instead of bag-like and hardened to form an effective organ of flight. The coloration of the fly is pale and the whole body somewhat soft and worm-like. But within an hour, sometimes, indeed, within a few minutes, the body has become perfectly indurated, the wings completely expanded, and the color-markings fixed to that of the imago.

After emergence the life of the fly is dominated by two impulses, the instinct to feed and the instinct to reproduce its kind. The food of the adult is practically always secured from flowers and consists of nectar and pollen. The flies seem to be strongly influenced by heliotropism or sunlight. They are almost always active in the sunshine and the brighter and warmer the day the more active they become. These facts may be taken advantage of by the person who wishes to collect Flower-flies. The most fruitful collecting is to be found about melliferous flowers and in the sunshine, particularly in very early spring.

Mating may take place on the wing with both sexes actively flying (hovering) and oriented in the same direction, the male uppermost (*Sphaerophoria, Sphegina,* etc.); or the pair may come to rest on foliage, in which case the two are usually facing in opposite directions, either resting or the male being passively dragged about from leaf to leaf by the female (*Temnostoma*). The process of copulation has been observed to continue for many hours at a time.

The next and final step in the completion of the life-round or life-cycle is oviposition for the next generation. The female, no longer closely attended by the male, hovers about the medium on which the larvæ are to feed settling down at intervals to place the eggs. The terminal segments of the abdomen with the ovipositor are greatly extended and the egg passes between the vulva to its position on leaf, filth, or other medium, according to the habits of the particular species. The eggs may be placed singly and greatly scattered, as in most of the predaceous species; or several may be placed closely side by side (*Melanostoma mellinum,* q. v.); or they may be deposited in great numbers in a mass, as in most of the filth-inhabiting species. In the latter case some of the species seem to rank the eggs in quite regular order; in others they appear to be simply extruded in a pile with little regard to their orientation. Often a gluey substance is passed with the egg which fastens it securely to some surface. Eggs succeed each other commonly at intervals of about a minute.

HABITS OF THE LARVÆ.

The habits of the larvæ of Syrphidae, which are remarkably varied, have formed an interesting subject of study for a number of years. Perris in 1870 (41) gave a brief resumé of the modes of life of these larvæ as known to him. Williston, 1886, (62, p. 271), Verrall, 1901, (55, p. 674) and the writer, 1913, (35, pp. 38-42) have amplified and extended this table to include additional habits and species as determined.

I have attempted to outline our present knowledge of the habits of these insects in a logical way in Figure 28. In the first column of this plate is a systematic analysis of the known larval habits. In the second are listed the North American species or genera known to follow any particular habit. And in the third the structure of these larvæ, so far as the writer has personally studied them, is indicated.

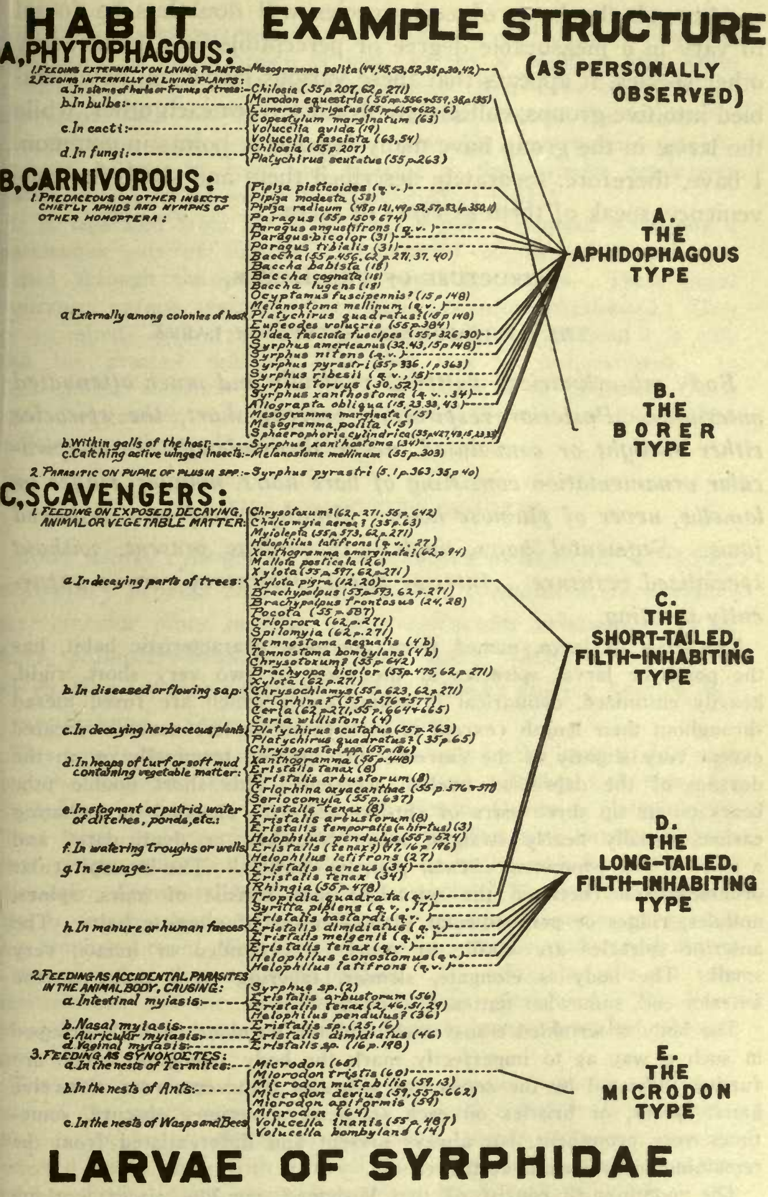
HABIT
EXAMPLE
STRUCTURE (AS PERSONALLY OBSERVED)
A, PHYTOPHAGOUS:
1. FEEDING EXTERNALLY ON LIVING PLANTS:—Mesogramma polita (44, 45, 53, 52, 35 p. 30, 42)
2. FEEDING INTERNALLY ON LIVING PLANTS:
a. In stems of herbs or trunks of trees:—Chilosia (55 p. 207, 62 p. 271)
b. In bulbs:
Merodon equestris (55 pp. 556 + 559, 38 p. 135)
Eumerus strigatus (55 pp. 615 + 622, 6)
c. In cacti:
Copestylum marginatum (63)
Volucella avida (19)
Volucella fasciata (63, 54)
d. In fungi:
Chilosia (55 p. 207)
Platychirus scutatus (55 p. 263)
B, CARNIVOROUS:
1. PREDACEOUS ON OTHER INSECTS CHIEFLY APHIDS AND NYMPHS OF OTHER HOMOPTERA:
a Externally among colonies of host
Pipiza pisticoides (q. v.)
Pipiza modesta (58)
Pipiza radicum (48 p. 121, 49 p. 52, 57 p. 83, 1 p. 350, 11)
Paragus (55 p. 150 + 674)
Paragus angustifrons (q. v.)
Paragus bicolor (31)
Paragus tibialis (31)
Baccha (55 p. 456, 62 p. 271, 37, 40)
Baccha babista (18)
Baccha cognata (18)
Baccha lugens (18)
Ocyptamus fuscipennis? (15 p. 148)
Melanostoma mellinum (q. v.)
Platychirus quadratus? (15 p. 148)
Eupeodes volucris (55 p. 384)
Didea fasciata fuscipes (55 p. 326, 30)
Syrphus americanus (32, 43, 15 p. 148)
Syrphus nitens (q. v.)
Syrphus pyrastri (55 p. 336, 1 p. 363)
Syrphus ribesii (q. v., 15)
Syrphus torvus (30, 52)
Syrphus xanthostoma (q. v., 34)
Allograpta obliqua (15, 23, 33, 43)
Mesogramma marginata (15)
Mesogramma polita (15)
Sphaerophoria cylindrica (35 p. 427, 43, 15, 23, 33)
b. Within galls of the host:—Syrphus xanthostoma (34)
c. Catching active winged insects:—Melanostoma mellinum (55 p. 303)
2. PARASITIC ON PUPAE OF PLUSIA SPP.:—Syrphus pyrastri (5, 1 p. 363, 35 p. 40)
C, SCAVENGERS:
1. FEEDING ON EXPOSED, DECAYING, ANIMAL OR VEGETABLE MATTER:
a. In decaying parts of trees:
Chrysotoxum? (62 p. 271, 55 p. 642)
Chalcomyia aerea? (35 p. 63)
Myiolepta (55 p. 573, 62 p. 271)
Helophilus latifrons (q. v., 27)
Xanthogramma emarginata? (62 p. 94)
Mallota posticata (26)
Xylota (55 p. 597, 62 p. 271)
Xylota pigra (12, 20)
Brachypalpus (55 p. 593, 62 p. 271)
Brachypalpus frontosus (24, 28)
Pocota (55 p. 587)
Criorhina (62 p. 271)
Spilomyia (62 p. 271)
Temnostoma aequalis (4 b)
Temnostoma bombylans (4 b)
b. In diseased or flowing sap:
Chrysotoxum? (55 p. 642)
Brachyopa bicolor (55 p. 475, 62 p. 271)
Xylota (62 p. 271)
Chrysochlamys (55 p. 623, 62 p. 271)
Criorhina? (55 p. 576 + 577)
Ceria (62 p. 271, 55 p. 664 + 665)
Ceria willistoni (4)
c. In decaying herbaceous plants:
Platychirus scutatus (55 p. 263)
Platychirus quadratus? (35 p. 65)
d. In heaps of turf or soft mud containing vegetable matter:
Chrysogaster spp. (55 p. 186)
Xanthogramma (55 p. 448)
Eristalis tenax (8)
Eristalis arbustorum (8)
Criorhina oxyacanthae (55 p. 576 + 577)
Seriocomyia (55 p. 637)
e. In stagnant or putrid water of ditches, ponds, etc.:
Eristalis tenax (8)
Eristalis arbustorum (8)
Eristalis temporalis (= hirtus) (3)
Helophilus pendulus (55 p. 524)
f. In watering troughs or wells:
Eristalis (tenax?) (47, 16 p. 196)
Helophilus latifrons (27)
g. In sewage:
Eristalis aeneus (34)
Eristalis tenax (34)
h. In manure or human faeces:
Rhingia (55 p. 478)
Tropidia quadrata (q. v.)
Syritta pipiens (q. v., 17)
Eristalis bastardi (q. v.)
Eristalis dimidiatus (q. v.)
Eristalis meigenii (q. v.)
Eristalis tenax (q. v.)
Helophilus conostomus (q. v.)
Helophilus latifrons (q. v.)
2. FEEDING AS ACCIDENTAL PARASITES IN THE ANIMAL BODY, CAUSING:
a. Intestinal myiasis:
Syrphus sp. (2)
Eristalis arbustorum (56)
Eristalis tenax (2, 46, 51, 29)
Helophilus pendulus? (36)
b. Nasal myiasis:—Eristalis sp. (25, 16)
c. Auricular myiasis:—Eristalis dimidiatus (46)
d. Vaginal myiasis:—Eristalis sp. (16 p. 198)
3. FEEDING AS SYNOKOETES:
a. In the nests of Termites:—Microdon (68)
b. In the nests of Ants:
Microdon tristis (60)
Microdon mutabilis (59, 13)
Microdon devius (59, 55 p. 662)
Microdon apiformis (59)
c. In the nests of Wasps and Bees:
Microdon (64)
Volucella inanis (55 p. 487)
Volucella bombylans (14)
A. THE APHIDOPHAGOUS TYPE
B. THE BORER TYPE
C. THE SHORT-TAILED, FILTH-INHABITING TYPE
D. THE LONG-TAILED, FILTH-INHABITING TYPE
E. THE MICRODON TYPE
LARVAE OF SYRPHIDAE

Fig. 28. An outline of the known habits and structure of the larvae of Flower-flies. The numbers following the names of species refer to papers in the bibliography.

Although the larva of each species will doubtless be found to vary in a measurable degree or perceptible way from every other species, it appears that these various larvæ can be assembled into five groups, collectively distinct from each other, while the larvæ in the group have many important points in common. I have, therefore, separately described them and shall, for convenience, speak of them as *types* of larvæ.

Structure of the Larvæ.

I. THE APHIDOPHAGOUS TYPE OF LARVA.

Body sub-cylindrical, flattened ventrally and much attenuated anteriorly. Posterior respiratory process short, the spiracles either straight or convoluted, never denticulated. Inter-spiracular ornamentation consisting of bare hairs, nodules, ridges or lamellæ, never of plumose hairs. Mouthparts of two Λ-shaped jaws. Segmental hairs single. If prolegs present, without specialized vestiture. Anterior pupal respiratory cornua apparently wanting.

This type of larva, named from the most characteristic habit, has the posterior larval spiracles at the apex of two very short, rigid, heavily chitinized, cylindrical breathing tubes which are fused mesad throughout their length (except in very young larvæ) never bifurcated except very slightly at the extreme tip; situated terminally or on the dorsum of the depressed twelfth segment. This short double tube bears on its tip three pairs of slit-like *spiracles* elevated on radiating carinæ, usually nearly straight, never branched or denticulate; and a more or less prominent *circular plate* or "button." The interspiracular ornamentation (between the spiracles) may consist of hairs, spines, nodules, ridges or perpendicular plates,—never of plumose hairs. The anterior spiracles are sessile or nearly so, rounded or lunate, very small. The body is elongate, slender, tapering to a point at the anterior end, somewhat flattened ventrally.

The body is wrinkled transversely and the wrinkles or folds grouped in such a way as to imperfectly mark the body segments, which are further indicated by the *segmental spines,* a transverse row of twelve hairs, spines, or bristles on each segment, sometimes obscure, sometimes very prominent, but always present and differentiated from the remaining *integumental* vestiture.

The mouth-parts consist of two V-shaped, jaw-like pieces working vertically and associated spines or hooklets; which, with the terminal anterior segments, are strongly retractile.

The integument is tough but thin and more or less transparent, either glabrous and papillose or closely set with minute stiff hairs (the integumental vestiture). The colors are various but commonly some shade of green, brown or pink, striped or blotched with white or black. Usually the dorsal blood-vessel (heart-line) shows as an interrupted black mid-dorsal line throughout most of the length.

In the pupa stage this type has a somewhat characteristic shape,—subovate, bulbous in front and tapering to the posterior respiratory process (which retains its larval characteristics) behind.

It is separated from the other types I have examined in lacking a conspicuous pair of anterior (prothoracic) stigmata developed and pushed through the puparium for pupal respiration. These pupal respiratory cornua appear to have been heretofore overlooked. They are so minute that even when one knows they are present it is only with the greatest difficulty that they can be demonstrated. In *Melanostoma mellinum* (q. v.), a species with unusually transparent integument, they can be located readily because the tracheæ leading from them are easily visible.

II. THE BORING TYPE OF LARVA.

Body nearly cylindrical, less attenuated anteriorly. Posterior respiratory process short, the spiracles convoluted, inconspicuous; circular plate sunken. Inter-spiracular ornamentation of short, palmately-branched, plumose hairs. Mouth-parts fitted for rasping, of two ventrally directed hooks uniting basally into a mouth-hood. Segmental hairs single.

This type is represented in my collection only by the larvæ of *Merodon equestris,* collected from Narcissus bulbs in British Columbia, for which I am indebted to Dr. C. Gordon Hewitt, Dominion Entomologist. These larvæ are superficially much like the first type but the body is more nearly cylindrical, less flattened ventrally, and less attenuated anteriorly. Segmental hairs single, prominent. The posterior respiratory process has lost nearly all trace of its double nature and appears as a truncated cone. The circular plates are deeply sunken and occupy a central rather than a dorsal position. The spiracular slits are very inconspicuous and are irregularly and much convoluted. The inter-spiracular ornamentation consists of short, palmately-branched, plumose hairs.

The anterior three body segments are directed ventrad and terminate in the mouth-parts. The latter entirely different from aphidophagous species, consisting of two black, heavily-chitinized, rasping, recurved hooks, each with a small, inner, basal spur, fused basad to form a heavy, black, ventrally-concave hood beneath which is the mouth opening.

I have not seen the pupa of this type.

III. THE SHORT-TAILED FILTH-INHABITING TYPE OF LARVA.

Body cylindrical with the anterior segments modified into a "false-head." Posterior respiratory process short, the spiracles convoluted and denticulated. Inter-spiracular ornamentation of short, palmately-branched, plumose hairs. No external mouth-parts but a chitinized mouth-hood. Three pairs of lateral, fleshy, conical protuberances on segment twelve. Segmental hairs triple or quadruple, flexible, inconspicuous. Rudimentary prolegs. Pupal respiratory cornua prominent, morel-shaped.

This type of larva is superficially like the Boring Type, but the anterior three or four segments instead of being accuminate are rounded out, globose, as broad as, or broader than, the succeeding segments, and somewhat separated from them by a slight neck-like constriction to make a kind of *false head.* There are no external, chitinized mouth-parts, the mouth opening being covered by a moderately-chitinized, striated mouth-hood, the termination of the cephalopharyngeal skeleton; and guarded on each side by a poorly defined, piliferous fold of skin.

The posterior respiratory process shows its origin from two tubes; the circular plate is on a level with the apex of the tube; and the slit-like spiracles which are more prominent are convoluted and also ornamented with more or less numerous lateral projections or denticles. The inter-spiracular ornamentation consists of plumose, palmately-branched hairs. The segmental vestiture consists of clumps of about three or four fine, flexible hairs, a little longer than the integumental vestiture, and all arising together. The larvæ have seven pairs of prolegs along the ventral side of the body, which consist of elevated folds of the body-wall over which the integumental vestiture is specialized into heavier, rigid and retrorse hooks of varying size.

This and the following types of larvæ differ strikingly from the first in producing for the pupa stage a pair of very conspicuous tubular, anterior respiratory cornua, studded with minute nodules and connected with the nymphal prothorax, as in the first type, by large tracheal trunks. These cornua in the three species examined are more or less mushroom- (morel-) shaped.

IV. THE LONG-TAILED (RAT-TAILED) FILTH-INHABITING TYPE.

Body cylindrical with a false head, and long tail. This posterior respiratory process elongate, telescoping, flexible, at least half as long as the body. The spiracles on its end entirely inconspicuous. Inter-spiracular ornamentation of single, long, plumose hairs. No external mouth-parts except the mouth-hood. Segmental hairs double or triple, flexible, inconspicuous.

Rudimentary prolegs present. Anterior pupal respiratory cornua elongate, cylindrical, very prominent.

This type is most closely allied to the third type but differs from it and from all the others in the remarkable elongation of the posterior respiratory organ, which, in these species, is tube-like, three-jointed and telescopic; and may be extended to several times the length of the body although commonly contracted to about body-length. This remarkable and highly specialized organ enables the larva to carry on aerial respiration while feeding at various depths beneath the water level. It is of two tubes fused mesad and enclosing two tracheæ which open at the tip. The inter-spiracular ornaments consist each of a single, unbranched, but plumose, long hair instead of a palmate group of short plumose hairs as in the two previous types. The prolegs are similar to type III. The anterior larval spiracles are unusually conspicuous, borne on a pair of cornua which are capable of considerable elevation although usually rather closely retracted.

The shape of the body is sub-cylindrical with the anterior segments forming a false head, and the mouth-hood as in type III. The terminal segment tapers strongly into the respiratory process. The integument is very flexible and transparent; segmental hairs double, similar to type III. The anterior pupal cornua are longer than in type III and nearly cylindrical, the enlarged distal part much longer than the basal stalk, hence the whole less mushroom-shaped.

V. THE MICRODON TYPE OF LARVA.

Body hemi-spherical; the flat surface ventrad, with a row of spines around its margin; dorsum reticulated. Posterior respiratory process short, the three spiracles on each half together making nine loops, convex outwardly and denticulated on their outer margin. Inter-spiracular ornamentation of non-plumose fine hairs. Mouthparts consisting of a ventral Λ-shaped jaw and two dorsal pieces placed Λ-shaped, but not fused at the apex. Segmental hairs and prolegs wanting. Anterior larval spiracles apparently wanting. Pupal respiratory cornua morel-shaped.

The larvæ of this genus are very aberrant and superficially show no relationship with the other larvæ of Syrphidæ, differing strikingly from all the others in shape. Instead of the elongate, sub-cylindrical body we have a nearly hemi-spherical body. The outline is short elliptical, the ventrum very much flattened forming a ventral sole around the margin of which is a circlet of ornamental spines. Dorsum almost uniformly rounded up. Mouthparts open in a longitudinal slit on the cephalic part of the ventral sole. Posterior respiratory process dorso-caudad, short, tubular, but with some indication of its double nature; circular plate medio-dorsad. The spiracular slits each of three outwardly directed loops, denticulated only on the outer side, almost arborescent in appearance but still divisible into three pairs. The interspiracular ornamentation of small, delicate, non-plumose hairs. No anterior larval spiracles have been demonstrated.

In place of the transverse folds or wrinkles on the dorsal surface, it is evenly convex and beautifully reticulated with lines of papillæ. I find no evidence of the segmental hairs.

The pupal respiratory cornua are similar to those of type III being much shorter than in type IV.

ECONOMIC IMPORTANCE OF THE LARVÆ.

The principal economic importance of the larvæ is four-fold, two of these relationships being beneficial and two of them detrimental to human interests.

A. BENEFICIAL HABITS.

1. *As predators.* By far the most important economic bearing of Syrphidae arises from the predaceous habit of many common species. Of the prey affected, aphids compose probably ninety-nine per cent. *Coccidae* and the young of *Aleyrodidae, Jassidae, Psyllidae and Membracidae* are also attacked, and occasionally even active winged insects such as Diptera may be caught (55, p. 311) or the larvæ of other Syrphidae devoured.

With the vast majority of species there is no close restriction to particular species of prey; although a few species such as *Didea fasciata* and *Pipiza pisticoides* have been found among only one or a few species of aphids.

For the most part the service of these insects is in preventing the abnormal increase of the various injurious species of aphids rather than in exterminating the colonies in any particular place; although the latter result is by no means uncommon. Their value is ordinarily due to their very uniform distribution and constant occurrence, rather than to tremendous numbers at any time or place. Nevertheless, instances of the occurrence of enormous numbers of them are not lacking. Perhaps the most notable of such records is that by W. G. Johnson (23, p. 97) regarding the abundance of larvæ during an outbreak of the pea-louse (*Macrosiphum pisi* Kalt.) in southern Maryland in 1899. I quote from Mr. Johnson as follows:

"The real importance of the Syrphus-fly larvæ in the reduction of the species [the pea-louse] was shown beautifully in southern Maryland, where they were so abundant the first and second weeks in June as to almost completely destroy the lice." And quoting further from his correspondent: "'The insects (lice) started to disappear last week and are now about all gone . . . The last few days I packed, the separators sieved out about 25 bushels of green worms [larvæ of Syrphidæ, chiefly *Allograpta obliqua*] which no doubt proves that they destroyed the lice.'"

Mr. Johnson states further that the Syrphid-flies did not save the crop that year but calls attention to their probable value in relation to future ravages of the pest. A conservative estimate shows that twenty-five bushels of the larvæ of *Allograpta obliqua* could scarcely represent less than 3,000,000 individuals. Presuming that the larvæ lived ten days and ate on the average twenty aphids a day (which I believe also to be a conservative estimate) such a multitude of larvæ would be responsible for the destruction of over half a billion aphids.

Another example of the extermination of aphid colonies by these predaceous larvæ is afforded by the attacks of *Pipiza pisticoides* on the Woolly Apple Aphis. These aphids became evident as above-ground colonies on apple, at Orono, about the first of August. At the same time several species of Syrphid larvæ also made their appearance among them, chiefly the larvæ of *Pipiza*. Shortly the Woolly Apple Aphis began to disappear, the aphids becoming scarcer and scarcer and the predaceous larvæ more and more evident, until by early September I found myself with many larvæ on hand and almost no aphids anywhere to be found as food for them. Doctor Patch tells me she has found this a rather common experience; and that year after year, the colonies of Woolly Apple Aphis on apple have practically disappeared in the presence of these predaceous larvæ, by mid-September. See also page 224.

The relentlessness of these enemies of aphids is illustrated in a peculiar way by the experience of the Station Entomologist, who for a number of years has been studying the aphids of the State. It is an altogether too common experience that aphid material mailed to her for study has been absolutely consumed *en-route* by Syrphid larvæ, inadvertently introduced into the package by the correspondent.

Hardly a colony of aphids can be found that is not being preyed upon by from one to half a dozen species and from one to dozens of individuals. They kill the individual aphids outright but on account of the rapid rate of reproduction of the latter the colony usually exists for some time at least.

I have been interested in getting some definite data as to the capacity of these larvæ for devouring their prey.

Specimens of *Aphis brassicae* proffered to a four-day old unfasted larva of *Syrphus americanus* were devoured at the following rate: Four minutes and 30 seconds, 2 minutes, 1 minute, 1 minute, 30 seconds, 3 minutes and 15 seconds, 2 minutes, 1 minute and 45 seconds, and 1 minute and 30 seconds; a total of nine aphids in seventeen and a half minutes (32, p. 481). In this test the aphids were touched to the mouth-parts of the larva as rapidly as the previous skin was discarded. It was thought that this represented an abnormal rate of feeding. Last summer the larva of *Syrphus nitens* was observed while feeding *normally* on the large aphids *Pterocomma flocculosa.* During a period of twenty minutes, twenty-one aphids were caught and destroyed. The larva had not been kept away from food nor were the aphids supplied for it or the process in any way hurried or artificial.

How much longer feeding at this rate may continue or how frequently such periods of rapid feeding may succeed each other, observations have not yet shown. However, it seems certain that the number of aphids destroyed by a single specimen during its larval existence of one or two weeks or longer must be very considerable.

Particularly when we consider the enormous numbers of progeny which may be prevented from developing by the destruction of even a single agamic female, the value of these agricultural benefactors may be more correctly judged. A point of great importance in this respect is that the Flower-flies infest the aphid colonies very early in the establishment of the latter; indeed, sometimes the Syrphid eggs are deposited on a plant in advance of its infestation by the aphids; so that numerous voracious larvæ may be awaiting the first appearance of the stem-mother and her progeny.

Another important point which enhances the destructive powers of the Syrphid larvæ, is that they eat—not the entire aphid—but only the soft and rapidly digestible body-contents.

"These aphidophagous larvæ, although frequently found entirely surrounded by an abundance of prey, are very often obliged to search about for food. Their characteristic, looping movements are very familiar to many people. When used for progression alone, these movements may be very rapid. Their progress is very similar to that of a 'measuring-worm' though the body is not so long. When the larva is searching for food, the anterior half or two-thirds of the body is raised in the air, very much extended, and lashed from side to side. It is then attached and the posterior parts pulled up, when the movement is repeated. Thigmotropism, and not chemotropism, seems to be involved in locating food. Hungry larvæ frequently pass by aphids so closely as almost to touch them, and go on in search of others. When a suitable aphid is found the larva frequently grasps it first by the leg or antenna and clings to this appendage until the thorax or abdomen can be reached. The mouth-parts are firmly attached to the body, the body-wall is punctured, and the aphid usually lifted high in the air. Then begins a process of slowly picking and sucking out all the body contents, which may continue from a fraction of a minute to more than an hour (in the case of very young larvæ). The action of the mouth-parts is very characteristic and very well adapted to the needs of the case. Many different muscles, which have their origin on the body-wall in the region of the head, are inserted upon the cephalo-pharyngeal skeleton, the jaws, and the mouth-hooklets. Some of them operate the framework in and out like a battering ram. Others at the same time open and close the jaws. The anterior two or three segments are inserted completely within the body wall of the aphid. The jaws are directed into every corner of the body and even into the bases of the appendages as they pick and suck out the soft contents. The skins, absolutely empty, are then discarded by retraction of the segments, the hairs or spines on those outside serving readily to dislodge the skin. These dead skins usually drop down or blow away but may sometimes be seen in numbers on the host-plant." (The Author, 35, pp. 26, 27).

2. *As Scavengers.* The other important way in which the larvæ of Syrphidae are beneficial to human interests is by their activities as scavengers. Considerable quantities of dead animal and vegetable matter are in this way reduced to simpler compounds, more readily assimilated by plants; and certain materials which are obnoxious, and may be a menace to health, are transformed to innoxious forms.

To quote from Comstock (10, p. 415):

"Although the habits of these creatures, which revel in all kinds of filth are very disgusting, we cannot help admiring that arrangement by which a mass of filth, instead of being left to poison the atmosphere, is transformed into myriads of living beings whose swift flight and delicate forms lend life and beauty to the landscape."

Happily, the breeding of these flies in excrement ordinarily causes no menace to human health; because (unlike the house-fly) they do not commonly visit human habitations and human foods, but confine their explorations as adults almost exclusively to flowers out-of-doors.

B. INJURIOUS HABITS.

Few large families of insects are on the whole less detrimental to human interests than the Syrphidae. Yet it is incorrect to state, as some of our text-books do, that none of the species are injurious; for although the family includes no well-known pests in this country, there are two important ways in which the Flower-flies are injurious in the larval stage.

1. *As Crop-Pests.* The few species which are phytophagous are occasionally seriously destructive to crops. The most notable of them in America is *Toxomerus** *politus* which has come to be known as the Corn-feeding Syrphid-fly. This species has been reported as feeding on corn in abundance as follows: New Jersey, 1885 (44), 1899 (53) and 1913 (42); Florida, 1886 (44); Missouri, 1889 (45); Delaware, 1900 (50); and North Carolina, 1913 (35). I found them (pupæ) abundant on field corn (in the axils of the leaves) at the Ohio State University farm, September, 1915; and Professor Z. P. Metcalf sent me larvæ and pupæ (attached among the glumes on the tassels) from West Raleigh, North Carolina, in late August, 1915 with the statement that they were again plentiful there.

The species is evidently widespread and common on corn, but only a few cases are known where its attacks were considered serious; notably in Florida and Missouri (*loc. cit.*). They feed on pollen grains and on the saccharine cells at the axils of the leaves. The former habit might seriously interfere with fertilization and the consequent yield of grain, if the larvæ were abundant; while the latter attack was stated to produce a wilting and browning of the lower leaves similar to the injury from chinch-bugs. This species is not yet recorded from Maine but will probably be found to occur within the State. The puparia are often heavily parasitized which may explain why they are not oftener seriously destructive.

**Mesogramma.*

In Europe the larvæ of *Merodon equestris* (55, p. 556) and *Eumerus strigatus* (55, p. 615) are pests of flowers such as Narcissus and Amaryllis, and of the onion among vegetables. The larvæ burrow into, and promote the decay of, the bulbs of these plants; in certain instances having destroyed thousands of plants. They have been introduced into North America and are transferred from place to place in infested bulbs, and there is reason to fear that their range will continue to be extended and that they may become serious pests in this country.

On July 25, 1916, a number of the adults of each of these two species was taken about blossoms in a nursery at Bar Harbor. No damage by the larvæ had been recognized by the nurserymen, but the number of adults present indicates that the species are established in the State or are quite likely to become so.

2. *As Transitory Animal Parasites.* The fourth important way in which larvæ of Flower-flies affect us is by their occasional occurrence in the living human or animal body and the accompanying disturbances or destruction of tissues. Myiasis is known to be produced by Syrphidae in four ways: First, by their presence in the alimentary canal (intestinal or gastric myiasis); secondly, by their introduction to the nasal cavities (nasal myiasis); thirdly, by their introduction to the auditory cavities (auricular myiasis); and fourthly, by their introduction into the vagina (vaginal myiasis).

The first of these is the more common. Probably it not infrequently occurs and is not recorded. On the other hand, many reported cases of larvæ having been passed from the bowel are doubtless erroneous due to the stools having become infected after passage. Hall and Muir, 1913, (16) have summarized the published data relative to myiasis due to Syrphidae and described an additional case. It appears that there are certain authentic cases on record where such larvæ have been passed alive, sometimes as many as twenty or thirty at a time. The presence of the larvæ in the intestine caused some of the following symptoms: Intestinal pains, vertigo, nausea, vomiting, constipation, headache, nervousness, weakness and emaciation.

The species known to be concerned in such infestation are *Eristalis tenax* (2, 46, 51, 29), *Eristalis dimidiatus* (46), *Eristalis arbustorum* (56) and possibly *Helophilus* (*Musca*) *pen-*

dulus (36). These are all larvæ of the long-tailed, filth-inhabiting type which live normally in sewage, putrid or stagnant water, in ditches or even in watering troughs (27), and wells (47; 16, p. 5).

The source of infection in certain cases has been explained as follows: By ingestion of eggs laid on cream, sour milk or cheese; by ingestion of eggs or larvæ in drinking water from springs, contaminated by the drainage from compost heaps or from stagnant pools or ditches; by eating water-cress or overripe fruit in which larvæ may be present; or by deliberate ingestion on the part of children. Any of these methods seems possible and all, except the first and the last, quite probable.

It is not difficult, as pointed out by Wagner (56), to see how these larvæ are able to exist in the alimentary canal, where the conditions would not differ greatly from their normal habitat in fæces. The food is similar, plenty of air is supplied by swallowing, and the mephitic gases are not greatly different. It is not quite clear how the larvæ manage to resist passage for many weeks, as certain cases indicate. They have no hooks which would enable them to attach to the intestinal wall unless, indeed, it be the minute ones on the prolegs, which seem inadequate.

Austen (2) reports two cases of intestinal myiasis due to the larvæ of *Syrphus,* which are not so easy of explanation; because what is known of the larval habits of this genus does not indicate a ready source of infestation, nor a likelihood that these larvæ would readily adapt themselves to the conditions of the alimentary canal.

The other kinds of myiasis due to Syrphidae are exceedingly rare. Leidy (25) has recorded a case of a rat-tailed larva stated to have been removed from the nasal cavity; Austen (2) a case of the invasion of the external auditory meatus by a *Syrphus* larva, resulting in pain and deafness; and Hall and Muir (16) record a case, reported to the Bureau of Animal Industry, U. S. Department of Agriculture, from Maryland in 1909, where eight larvæ of *Eristalis* were stated to have been passed in a jelly-like substance from the vagina of a cow. The source of infestation in such cases as these is doubtless oviposition by the fly directly in these natural cavities of the body; especially if the latter were in a diseased or uncleanly condition.

In this connection, I wish to emphasize the practical impossibility, at our present state of published knowledge, of referring larvæ found in such circumstances to a definite species, or even to the genus, unless specimens are reared to the adult. It seems to be the custom to refer any rat-tailed larva to *Eristalis tenax*, or at least to the genus *Eristalis*. Such records, unless based on adults reared from the larvæ, must, it seems to me, be discarded as of no specific importance. I am working on the problem of separating these different species in the larval stage, and have examined a dozen species of rat-tailed larvæ belonging to several genera, the separation of which is exceedingly puzzling and difficult, and any one of which might easily be mistaken for the larva of *Eristalis tenax*.

Other biological relations of the larvæ, of more or less economic importance, may arise from their association with other insects, in aphid colonies, or in the nests of colonial insects; and with their predaceous and parasitic enemies.

ECONOMIC IMPORTANCE OF THE ADULTS.

While the principal economic importance of Syrphidæ arises from the habits of the larvæ, the adults are by no means devoid of importance in this respect. The adults, so far as known, feed almost exclusively on the nectar and pollen of flowers or the honey-dew of insects. Anyone who has observed the tremendous numbers of these flies which mingle with Hymenoptera about all sorts of melliferous flowers, will be able to appreciate their importance in the cross-fertilization of entomophilous plants. All sorts of fruit and shade trees, wild and cultivated flowers, and certain field and garden crops, are regularly visited by these flies. Some of the flies, which possess an abundant vestiture, often of spurred and branched hairs, are very admirably adapted for the carrying of pollen. This is a subject deserving of careful observation. But in the absence of much definite data it seems safe to ascribe to this family a very large share of credit for this beneficient work, which is usually attributed to Hymenoptera alone.

Practical Measures.

Since the above analysis shows that the economic importance of the Syrphidæ is overwhelmingly beneficial, one is naturally desirous of knowing what could be done to favor, or foster them and increase their numbers.

1. The first thing to be done it seems to me is to educate people and especially agriculturists to discriminate between these Flower-flies and stinging Hymenoptera. The writer knows from personal observation that many of these beneficial insects are constantly being killed as "sweat-bees" under the impression that they can sting. Whereas, *they are absolutely unable to harm the person in any way; and furthermore, are, both as larvæ and adults, (with the exception of a very few species) among the farmer's most valuable animal friends.*

There are several simple ways in which these two groups can easily be distinguished in spite of the great resemblance in color, form and habit. *If the insect is flying,* the Flower-fly can be recognized by its distinct manner of flight, which has given the group the name of "Hover-flies." They constantly poise in the sunlight, or about flowers, remaining suspended in one place for a considerable time without any apparent movement of the body, the wings beating so rapidly as to be practically invisible; then dart away and quickly return, the body always in a tense horizontal position. Bees, when flying, habitually weave back and forth or bob up and down. On closer inspection most of the species can be distinguished by the shorter antennæ ("feelers") which are not easily seen in flight; while the antennæ of the bee are usually visible in front of the head. *If the insect comes to rest,* the Flower-fly is apt to keep its wings partly spread, the bee or wasp to fold them closely or cross them at the tips. *If you have the insect in your hand,* see if the wings on one side can be separated into two readily. The bees have two pairs of wings hooked together, but easily separable; the Flower-flies of course have only one wing on a side. Back of the base of the wing in the Flower-flies is a small knobbed thread (Fig. 29-4) visible to the naked eye on very careful examination, wanting in the Hymenoptera. And, finally, if a hand lens is available look for the false vein (Fig. 34-7) on the wing, which is the most distinctive characteristic of the Syrphidæ.

2. Not only should the adults be spared but the larvæ (Figs. *29-1; 30-6; 34-1*) on plants, among aphids, should be given careful protection. Too often they are killed under the supposition that they are damaging the plant. The figures and descriptions should enable one to distinguish these larvæ; but, if there is any doubt, careful observation will usually be rewarded by seeing one of them attack and devour an aphid.

3. The writer, with the assistance of Mrs. Cleo Fouch Metcalf, is investigating the effect of contact insecticides, such as are used for plant-lice, on these predaceous larvæ, in the hope that an effective spray for the aphids may be found which will not destroy the larvæ. In this way the latter might be left on the plants to seek out and destroy any aphids which escaped the spray, and thus tend to make the control measures perfect. The investigation has not gone far enough to justify conclusions, but it may be said that in laboratory tests a solution of Black Leaf 40*, 1 to 1000 of water with soap added, killed every aphid and only a small percentage of the larvæ. The effect of this insecticide on the larvæ under field conditions will be further observed.

4. During late summer and autumn, especially, a large percentage of the puparia of Flower-flies are parasitized by a small wasp which kills them. Such puparia can be easily told, after a little experience, by the fact that they do not completely inflate dorsally and soon become darker in color than normal. Much good could be done by careful observers in destroying such parasitized puparia wherever found.

SPECIES REARED IN THE STATE.

During the summer of 1915 at this Station, I succeeded in rearing from eggs or larvæ twenty species of Syrphidæ, nine of which have apparently not previously been described in the immature stages. These species fall into three of the structural types of larvæ already described, as follows:

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*Made by the Kentucky Tobacco Product Co., Louisville, Kentucky.

I. *Aphidophagous Species.*

Paragus angustifrons Loew.
Pipiza pisticoides Willist.
Melanostoma mellinum Linné.
Sphaerophoria cylindrica Say.
Sphaerophoria sp.
Syrphus sp.
Syrphus americanus Wied.
Syrphus ribesii Linné.
Syrphus torvus O. S.
Syrphus xanthostomus Willist.
Syrphus nitens Zett.
Didea fasciata Macq. var. fuscipes Loew.

II. *Short-tailed, Filth-inhabiting Species.*

Tropidia quadrata Say.
Syritta pipiens Linné.

III. *Long-tailed, Filth-inhabiting Species.*

Eristalis bastardii Macq.
Eristalis dimidiata Wied.
Eristalis arbustorum Linné.
Eristalis tenax Linné.
Tubifera lineata Fabr. (Helophilus conostoma Willist.)
Tubifera trivittata Fabr. (Helophilus latifrons Loew.)

The Short-tailed and Long-tailed Filth-inhabiting species were, all except the last species, reared from decomposing human fæces at the mouth of a sewer. *Tubifera trivittata* (*Helophilus latifrons*) was breeding in old and dried, but recently water-soaked, droppings of cattle, and soft black mould about stumps in an old stumpy pasture where heavy rains had left numerous pools of shallow water.

The aphidophagous species named above and others not determined were found preying on 33 species of Aphididae and two species of Psyllidæ as follows:

List of Homoptera* Attacked by Syrphidae in Maine as Observed in 1915.

APHID.	HOST PLANT.	SYRPHID.
Aphis viburnicola	Viburnum opulus	*Syrphus ribesii* *Sphaerophoria cylindrica*
Aphis viburniphila Patch mss.	Viburnum opulus	
Aphis cardui	Plum	*Syrphus* sp. *Sphaerophoria* sp.
Aphis cerasifolii	Prunus virginiana	*Sphaerophoria cylindrica* *Syrphus* sp.
Aphis pomi	Apple	*Syrphus americanus*
Aphis spiraecola	Spiraea	*Syrphus torvus* *Sphaerophoria* sp.
Aphis spiraephila	Wild Spiraea	*Paragus angustifrons*
Aphis sanborni	Flowering Currant	*Paragus angustifrons* *Sphaerophoria* sp.
Aphis rumicis	Syringa	*Sphaerophoria cylindrica*
Aphis rumicis	Evonymus alatus	
Aphis rumicis	Broad-leaf Dock	
Aphis helianthi	Cornus	*Sphaerophoria cylindrica*
Aphis cornifoliae	Cornus	*Sphaerophoria* sp.
Macrosiphum rosae	Rose	
Macrosiphum solanifolii	Rose	*Sphaerophoria cylindrica*
Macrosiphum rudbeckiae	Goldenrod	
Macrosiphum sp.	Anaphalis margaritacea	
Myzus cerasi	Plum	
Myzus cerasi	Wild Cherry	*Syrphus* sp. *Sphaerophoria cylindrica* *Sphaerophoria* sp.
Myzus cerasi	Prunus sp.	*Sphaerophoria cylindrica*
Myzus persicae	Rape	*Melanostoma mellinum* *Sphaerophoria cylindrica* *Sphaerophoria* sp.
Myzus sp.	Currant	
Rhopalosiphum nymphaeae	Plum	*Syrphus ribesii* *Syrphus* sp. *Sphaerophoria cylindrica*
Rhopalosiphum nabali	Prenanthes sp.	
Phorodon humuli	Plum	*Syrphus ribesii* *Syrphus torvus* *Syrphus* sp. *Sphaerophoria cylindrica*
Pterocomma flocculosa	Willow	*Syrphus nitens* *Syrphus americanus* *Didea fasciata fuscipes*
Siphocoryne xylostii	Snowberry	
Symdobius oblongus	White Birch	*Syrphus americanus*
Chaitophorus populifoliae	Poplar	*Syrphus ribesii*
Chaitophorus sp.	Willow	
Schizoneura americana	Elm (Curl)	
Schizoneura lanigera	Apple	*Pipiza pisticoides*
Tetraneura graminis	Elm (Cock's Comb Gall)	
Prociphilus corrugatans	Amelanchier canadensis	
Prociphilus fraxinifolii	Ash	*Syrphus* sp.
Thecabius patchii	Populus balsaminifera	
Hamamelistes spinosus	Birch	*Syrphus ribesii*
PSYLLID.		
Psylla striata Patch	Birch	
Psylla cerasi Patch	Prunus Pennsylvanica	

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* Identifications by Dr. Edith M. Patch, Entomologist.

DESCRIPTIONS OF LIFE-STAGES AND LIFE-HISTORIES OF MAINE SPECIES.

PIPIZA PISTICOIDES Williston.

This species is one of the most important if not *the* most important natural enemy of the Woolly Apple Aphis (*Schizoneura lanigera*) about Orono. The larvæ were plentiful among the above-ground colonies of this aphid, especially during August. The eggs are laid by adults, doubtless of a spring generation (developing among one of the elm Schizoneura?), as soon as the aerial colonies of the aphis are established on the apple.

Good-sized larvæ were collected August 3, 16 and September 1. Pupæ were formed August 14, 21 and 24, the adults emerging from 11 to 13 days later.

So rapacious are these larvæ that they practically exterminated the Woolly Apple Aphis about Orono by the first half of September. Dr. Edith M. Patch tells me this is the usual experience year after year.

Walsh and Riley (48, 49, 57) have described and figured a species of this genus, which was found feeding on *Schizoneura lanigera* and *Phylloxera vastatrix,* under the name of "The Root-louse Syrphus-fly (*Pipiza radicum* n. sp.)." Osten Sacken (38, p. 120) listed this species as a synonym of *femoralis* as did also Williston (62, p. 26) with a query. The type specimen appears to be lost but Coquillet (11) concludes from a comparison of the original description with the type of *Pipiza pistica* Williston that they are the same, hence the latter a synonym of *radicum,* and consequently that "the root-louse Syrphus-fly" should be known as *Pipiza radicum* Walsh and Riley, being distinct from *femoralis* Loew.

Williston (62, p. 29) at the same time that he described *Pipiza pistica* described another species, *P. pisticoides,* from a single female from Mount Washington, as follows:

> "Resembles *P. pistica* very much but seems evidently different. The third joint of the antennæ is orbicular, as broad as long; the pile throughout is shorter on the abdomen scarcely discernible; the size is also distinctly smaller."

Certain specimens collected in Ohio and one specimen, reared from an overwintering puparium among *Schizoneura americana* on Elm agree with Williston's description of (*pistica*=) *radicum*. In these species the third joint measures, — maximum width, .32 mm. by maximum length about .5 mm., the ratio being roughly 1:1.6.

However, the specimens reared in Maine are much less evidently pilose, and have the third antennal joint noticeably smaller and more elongate; measuring, maximum width, .25 mm., maximum length .42 mm., the ratio being roughly 1:1.7.

Another difference between the above groups of specimens (which may or may not hold true for a larger series) is in the length of the posterior, or medio-cubital, cross-vein at the outer end of the discal cell. In the Maine specimens (*pisticoides*) this vein is about .45 mm. long, one-fourth shorter than in the Ohio specimens (*radicum*) where it measures nearly .6 mm.

The above specimens are therefore referred to *Pipiza pisticoides*.

Larva. (Fig 29-*1*) Dimensions, average of eight, length, 6.75 mm., maximum width, 2.3 mm., height 1.8 mm. A wrinkly, moderately spiny, pale-yellowish or flesh-colored larva, usually much obscured by the woolly excrescence of the aphids among which it is found. Segments 5 to 11 inclusive of nearly equal width, the fourth and twelfth a little more than half as wide. The remaining anterior segments retracted except when the larva is active, then strongly accuminate to the terminal mouth-parts. Mouth-parts of the aphidophagous type with slender accessory thorns and a pair of prominent, short and heavy lateral mouth-hooks. The anterior larval spiracles slender, inconspicuous.

Each segment with one prominent, and two less prominent, transverse wrinkles, the latter sometimes sub-divided. The produced edges of the segments form two, zig-zag, lateral carinæ one above the other, composed chiefly of the fleshy, conical elevations which bear the dorso-lateral and lateral segmental spines. The entire dorsum covered with minute, close-set pale integumental spines, .015 to .03 mm. long, with broad bases and acute tips. The segmental spines likewise pale, about .1 to .15 mm. long, of two sub-equal parts, the terminal part slender, accuminate, the basal part more than twice as broad.

The posterior respiratory process with a moderate constriction about mid-length; the basal half sub-conical fleshy and papillose, the distal half polished sub-cylindrical, a little flattened dorso-ventrad, at the tip evidently of two tubes fused mesad. The entire process is elevated to a length of about .5 or .6 mm.. the polished distal part measuring about .25 mm. in length; maximum width about .25 mm., maximum heigth about .15 mm. The spiracular slits prominent, usually raised on radiating carinæ. Length of median spiracle about .065 mm., its width about .015 mm. The two stigmal plates separated by a median incision. The circular plates or "buttons" prominent, situated a little dorsad, .035 to .04 mm. in diameter, their inner margins separated by about half their diameter. The inter-spiracular ornamentation consists of four pairs of prominent slender bristles or hairs (Fig. 29-*2*) about .04 to .05 mm. long, a pair dorsad and ventrad of the circular plate, respectively, and one in each of the other interspiracular spaces.

Puparium. (Fig. 29-*3*). Length about 4.75 mm., height about 2 mm., width 2.25 mm. to 2.4 mm. Ventral line strongly concave, the dorsal line moderately elevated, producing almost a semi-circular curve from mouth-parts dorsally around to the posterior respiratory process. Greatest depth and width about the anterior third, tapering moderately on each side to within one millimeter of the posterior respiratory process, thence rapidly to that organ, which occupies a terminal position. Nearly circular in outline as seen from in front, slightly flattened ventrally. Color testaceous brown. Segmental and integumental spines not visible to the naked eye, but giving the puparium a spinulose appearance when somewhat magnified. Other characteristics as in the larva.

Adult. (Fig. 29-*4*). Uniformly black, about 6 mm. long. Antennæ black above, lower half of first and second joints and third joint on basal half of lower side yellow; the distal half and upper side all black. Arista as long as second and third joints together. Front black pilose, a few white hairs across the middle. At each side midway between ocelli and base of antennæ a white pollinose spot. A similar, narrow, elongate stripe of the same pollen on upper part of facial orbits. Face with rather sparse white pile, the eyes and posterior orbits short, white pilose. Thorax and abdomen shining metallic black, finely ruguloso-punctate, with very fine short white pile. Legs black with white pile, the following parts yellow; tips of all the femora, the broad base and narrow tip of the four front tibiæ, the narrow base of hind tibiæ and basal joints of the four front tarsi.

MELANOSTOMA MELLINUM Linné.

One of the most common species throughout North America and in Europe. Of their abundance Schiner (Fauna Austr. i. 291) says (translating freely):

"I have brought in thousands from all possible situations. They are found on every trip and finally tire the poor dipterologist because, while always apparently new, they nevertheless prove, upon closer examination to be nothing but varieties of the same variable species."

Verrall (55, p. 311) writes: "The larvæ of this species are believed to be aphidophagous as they have been bred from *Aphides* on *Chrysanthemum leucanthemum,* but M. A. Giard in Bul. Soc. Ent. France, 1896, p. 234, traced and bred many larvæ which occurred on the umbels of *Daucus carota* (on plants which bore no *aphides*) and which lived on the bodies of *Musca domestica* and *Chortophila pusilla;* the larvæ attacked these flies at the junction of the neck with the thorax and held on for one or two days before pupating."

On July 24, 1915, I found in a field of oats and wild mustard on the Station farm, many females of this species, their abdomens greatly distended with eggs. They seemed to be feeding on the blossoms of the mustard and no signs of oviposition were found. No aphids could be found on these plants. The ova of the flies were plainly visible through the thin, distended and transparent abdominal sterna and pleura, especially of the posterior half of the abdomen. Only a single male was taken and no others seen. Whether this indicates a relative scarcity of males or simply that the gravid females were more easily taken I am unable to say,—propably the former.

Twelve females were placed in jars with the single (available) male. Two days later July 26, 7 A. M., a large number of eggs had been deposited on the sides of the jar and on grass enclosed; probably having been laid during the night. July 28 by 8 A. M., the eggs were hatching, the duration in the egg stage having been between two and two and a half days. Not being certain of the larval habits, I placed the young in a variety of situations and offered them a variety of substances for food. The only noticeable result was the decided preference shown by the larvæ for very moist situations. From the variety of aphids offered them they seemed to show a preference for *Aphis cornifoliae* from *Cornus* although no larvæ were found among this species in the field.

The larvæ fed in captivity developed rapidly and began pupating August 14.

The following are the dates of pupation and subsequent emergence of adults from the eggs laid July 26.

Pupated	August	14	Parasite	emerged	August	26
"	"	16	♂	"	"	26
"	"	17	♀	"	"	23
"	"	20	♀	"	"	27
"	"	20	♀	"	"	30
"	"	23	♀	"	Sept.	3
"	"	26		"	"	4

Again on August 12 a female in captivity deposited a number of eggs. They were placed quite rapidly at intervals of about a minute. The following is the rate at which ten successive eggs were laid: 48 sec., 3 min., 2 min., 3 min., 4 min., 1 min. and 20 sec., 1 min., 1 min., 1 min., 1 min.

The above eggs had practically all hatched over night previous to 8 A. M., August 16; the duration in the egg stage having been about 4 days.

On August 7 a number of females were found hovering about among a very dense growth of rape on the Station farm. Careful examination revealed an abundance of eggs, which later proved to be this species, deposited on the under side of the lower leaves near the ground where it was constantly wet or damp. The eggs were ranked quite closely side by side in groups of from 2 to 8, more commonly 4 or 5 (the sides of the eggs touching each other). These eggs hatched August 11. The larvæ were apparently half-grown by August 23, and began pupating August 31 to September 4.

At the same time (August 7) a large number of larvæ of all sizes, and pupæ in all stages of development, were found on the under side of the leaves among the rape. The larvæ apparently sought out the moist places near the ground. These plants were infested with *Myzus persicae* but the aphids present at this time were fewer in numbers than the predaceous larvæ. It seems to me likely that here is a case where an infestation of aphids, which must have been severe to mature so many hundreds of larvæ, had been all but exterminated by the predaceous larvæ. This opinion gains confirmation from the fact that many of the pupæ present were undersized and somewhat misshapen, such as often results from starving larvæ. The larvæ collected were placed in all conceivable situations to see if possibly they might feed on some other food; but all foods were refused except aphids. They showed a preference for *Myzus persicae* and *Aphis cornifoliae* from *Cornus.* Fed on these aphids in captivity the larvæ pupated between August 7 and 11, and adults or parasites emerged August 14 to 18.

Of larvæ collected August 16 two pupated August 24, one emerging as adult August 28 the other August 31; another pupated September 4 and emerged as adult September 9.

Egg. (Fig. 30-*1*, *2*, *3*). Of the usual Syrphid shape, sub-cylindrical, a little broader and more rounded at one end, narrower and truncated at the micropylar end. The dimensions of 56 eggs from several different females were as follows: The length ranged from .8 mm. to 1.057 mm., with an average of .96 mm.; the maximum width ranged from .315 mm. to .4 mm. with an average of .36 mm. Figure 30-*1* and *2* is from camera-lucida drawings of three masses of eggs as found in nature. The sculpturing on the egg-shell (Fig. 30-*3*) consists of irregularly-shaped elevations 5 to 10 times as long as broad and separated by depressed areas several times their width. Each elevation has around its border a varying number (commonly about a dozen) of short, irregularly-sized and unsymmetrically-placed, lateral extensions. Forty-five to fifty of these elevations occur end to end the length of the egg, and eighty to ninety side by side around its circumference. Color: chalk white.

Larva. (Fig. 30-*4*, *5*, *6*). Length when well extended 8 to 9 mm., width about 2.5 mm. Color saturate lettuce-green, a little more yellowish mediad. One of the most characteristic things about this species is the unusual transparency of the integument and the unusual plainness with which much of the viscera shows through the body wall. Integument finely papillose but without vestiture. The segmental spines consist of a fleshy, sub-conical base surmounted by a slender blunt peg of about equal height, the whole small, light-colored, entirely inconspicuous. The greenish color is usually entirely obscured mediad, from a little in front of the middle, backward, by a black mass of visceral matter. This mass extends nearly half the total width but is overlaid on each side by several longitudinal chains of whitish, adipose cells, which extend throughout about the posterior two-thirds of the body. Between the latter is a longitudinal, pulsating heart-line,—entirely dull black except where it is crossed by folds of the intestine. Laterad of the several whitish chains of cells, and to some extent among them, the black again appears. Near the mid-dorsal line in the second fourth of the body on each side is a single chain of black polygonal cells. The lateral third of the body and all of the anterior end entirely greenish, except for a slender white line on each side formed by the longitudinal tracheal trunks, which run from anterior to posterior spiracles. These trunks give off fine superficial branches mediad at each segment.

The transverse folds of the integument and the division into somites are inconspicuous, as are also the antennæ and anterior spiracles. The latter are a little more than usually elongate and conical. The double Λ-shaped mouth-parts may be seen through the segments at the anterior end or terminally when extended. There is a pair of heavy, black, lateral mouth-hooks. Just in front of the posterior respiratory organ, between the two tracheal trunks, is a mass of very finely-divided white filaments (tracheæ?) especially noticeable when the larval skin is moist.

The posterior respiratory process is about .3 mm. broad at the end, about .17 mm. in depth, and elevated above the surface of the last segment only to a length of about .1 mm. or .12 mm. Circular plate evident; the three pairs of spiracles unusually short, less than twice as long as broad,—.05 mm. long by about .03 mm. wide. The interspiracular ornamentation consists only of four pairs of short, rounded nodules. A moderate emargination between the two stigmal plates.

Superficially the larva resembles most closely those of *Sphaerophoria cylindrica* or *Allograpta obliqua* (*q. v.*) being about the same size and similar in color and structure. However, besides the greater transparency of the integument in this species, *Melanostoma mellinum* can be very certainly separated from the other two species; *first,* by the shorter, more nearly sessile, posterior respiratory organ which is less than half as long as broad, whereas in *Sphaerophoria cylindrica* and *Allograpta obliqua* it is considerably longer than broad; *secondly,* by the greater length of the individual spiracles on the posterior respiratory process in *S. cylindrica* and *A. obliqua.* In *M. mellinum* the slit-like spiracles are less than twice as long as broad, while in the other two species they are each at least three times as long as broad.

Puparium. (Fig. 30-*7*, *8*, *9*). Length 6 to 7 mm., width about 2 mm. to 2.25 mm., height about 1.7 mm. to 2 mm. Usually broadest and highest about the anterior fourth. Very moderately elevated, the posterior half of the body being especially attenuated, the dorsal line descending very gradually to the posterior respiratory process. Color dilutely greenish or yellowish. The larval skin retains its great transparency in the puparium so that the developing imago is quite plainly discernible. On this account this is one of the very few puparia of the aphidophagous type on which anterior pupal spiracles or cornua can be detected. These (Fig. 30-*7* *A*) are located near the cephalo-dorsal corner of the puparium and appear as mere specks even at moderate magnification, being about .025 mm. across. Hence they would be entirely obscure (as they are in most related species) if it were not that the relatively large tracheal trunks leading from them to the prothorax of the nymph can be discerned through the puparium.

When highly magnified (Fig. 30-*8*, *9*) the pupal respiratory cornuum is seen to be a nearly cylindrical elevation, a half longer than broad and the end differentiated into eight denticles, evenly distributed and not contiguous, around the circumference of the apex and extending a short distance down the sides. Each denticle oval in outline, several times as long as broad.

Adult. (Fig. 30-*10*, *11*, *12*, *13*). Length 6 to 7 mm. *A brilliantly shining, metallic black species with bright yellow spots on the abdomen; facial tubercle small; hind metatarsi not thickened*

In the male the frontal triangle a little prominent with a pit in the middle; in the female the frons with a broad shallow transverse depression. Frons and face shining, whitish-dusted on the sides. Antennæ yellow to black, usually brownish on upper half, yellowish below except at tip of third segment, arista very briefly and short pubescent, nearly bare, yellow at the base. Abdomen *in the male* (Fig. 30-*13*) about four times as long as broad, dull black with three pairs of yellow spots; the first pair on the middle of the second segment, inner ends rounded; the others at the basal corners of the third and fourth segments, subquadrate, a little longer on the median side extending broadly over the margins. *In the female* the abdomen (Fig. 30-*12*) is shorter and oval, shining, with four pairs of orange spots the first pair small, isolated, near the middle of the segment; the third and fourth pairs subtriangular, touching the anterior margins, the posterior point rounded, the spots (either isolated or) narrowly reaching the side margins at the extreme base of the segment; the fifth segment with a pair of small slender basal spots. Legs variable, yellow to black.

SPHAEROPHORIA CYLINDRICA Say.

(See also 33, p. 538 and 35, p. 59).

This is an exceedingly common, and one of the most valuable aphidophagous species about Orono, and probably throughout North America. It has a variety of species of prey and may be expected in almost any colony of aphids.

Partly grown larvæ were taken June 17 from among *Aphis viburnicola* on *Viburnum opulus;* were full grown by June 28, in puparium June 30 and emerged as adults July 7. Other larvæ collected from the same source June 25, pupated July 2 and emerged July 9.

On July 7 four larvæ and one pupa were collected on Rose among *Macrosiphum solanifolii,* but all were parasitized.

A small larva collected July 14 among *Aphis rumicis* on *Evonymus alatus* was full grown and pupated July 24, emerging July 30. On the same date larvæ were collected from *Myzus cerasi* on wild cherry and a pupa from *Phorodon humuli* on plum. The former pupated July 17 and all emerged July 22.

On July 16 a pair were taken *in coitu* about blossoming turnip at 10 A. M. By 3 P. M. of the same day the female was ovipositing which continued until the death of the female on July 19. By the latter date many of the eggs were hatching.

July 26 two parasitized larvæ were taken from *Aphis cerasifolii* on *Prunus virginiana* and July 28 two puparia from the same host, the flies emerging August 3 and 6. July 31 a puparium was taken from flowering currant, the adult emerging August 7. And on the latter date larvæ and pupæ were found in all stages of development on rape, sparingly infested with *Myzus persicae.* Adults from these puparia emerged August 14.

Egg. Of the usual shape, less pointed anteriorly than that of *Allograpta obliqua* (Fig. 31-*61*, *62*). Length of twelve eggs measured, ranged from .91 mm. to 1.015 mm., with an average of .958 mm.; the maximum diameter from .32 mm. to .37 mm., the average .34 mm. Color, chalk white, sculpturing similar to that of *A. obliqua* (Fig. 31-*63*) but the elevated bodies a little shorter and broader than in that species, about two or three times as long as broad; distance between bodies about half their width; number of arms around each, 12 to 20; rather short, not much branched, many ending at half the distance across the intervening space. Number of bodies around the egg at the middle about 50; number the length of it about 30.

Duration in the egg stage about two or three days. The eggs are laid singly at short, varying intervals of time. In captivity the female always moved about after each egg was laid before depositing another. The actual process of placing the egg is speedily accomplished, the egg slipping out of the much extended ovipositor very quickly. The end is touched to a leaf where the "glue" fastens it and the ovipositor is then quickly drawn away from it, retracted, and the fly crawls away some little distance when the process is repeated. In the field the insect *flies* about from place to place, occasionally resting briefly on the under side of a leaf for the deposition of an egg. This habit of scattering the eggs of aphidophagous species is of value in preventing the too great congregation of larvæ and consequent scarcity of food. In captivity the insect frequently rested and manipulated the extended ovipositor with her hind legs, rubbing the metatarsi over it. Whether this is a natural habit or induced by some artificial condition (as, possibly, contact with the sugar solution supplied as food) I do not know. The female laid eggs at the following rate: 4 minutes, 7½ minutes, ½ minute, ¾ minute, 2¼ minutes. About 60 eggs were laid by a female taken *in coitu* and kept confined.

Larva. (Fig. 31-*76*). Length 9 to 10 mm., height 1.25 mm., width 2.25 mm. Elongate oval, tapering at anterior end, somewhat truncate except for respiratory appendage at posterior end, depressed. Outline irregular, dorsal integument much wrinkled transversely, and with lateral, longitudinal carinæ. Color pea-green with two, narrow, longitudinal, white stripes, laterad of and paralleling the rather conspicuous dark heart-line. The stripes attenuated and confluent a little before the anterior end, not reaching the respiratory appendage posteriorly. Respiratory appendage brownish black at the tip. The skin papillose, bare except for the usual segmental bristles which are here short, light-colored and inconspicuous. There are a number of poorly defined proleg-like projections of the body on the ventral side. The mouth-parts

(Fig. 31-*77*) consist of three pairs of hooklets in addition to the pair of jaws. One pair of hooklets is short and heavy, triangular, lateral in position (Fig. 31-*77 d*), the other two pairs, situated close beside the jaws (*c*), are slender, elongate, slightly curved. The jaws (*b*) are of the usual type but U-shaped rather than V-shaped, the shoulders rather prominent, with a median, terminal, pointed projection.

The antennæ (Fig. 31-*77*, *a*), and anterior spiracles are rather well elevated. The latter on a fleshy base with a prominent constriction beyond the middle showing at the apex a small number of rounded teeth or lobes about three larger and three smaller ones, (Figs. 31-*74*, *75*).

The shape, color and general appearance is very similar to the larva of *Allograpta obliqua*.

The two species can, however, be very certainly and definitely separated on the basis of the posterior respiratory appendages. These are about the same length and other dimensions; the difference lies in the distal end. As described in *Allograpta obliqua* the two tubes are slightly divergent at the tip making them broader here than at mid-length, and bear between each two spiracles a short, but readily visible, spur-like elevation continued as a slight ridge down the side of the tube. In *Sphaerophoria cylindrica* the end of the tube is very nicely and evenly rounded off; the spiracles very slightly elevated; the two tubes slightly emarginate but not at all divergent, and all trace of inter-spiracular spines or projections lacking. The posterior respiratory appendage .35 to .415 mm. long, .31 to .335 mm. wide, .15 to .175 mm. high. The median spiracle about .065 mm. long. The circular plates .035 to .04 mm. in diameter, their inner margins about .065 mm. apart. With the aid of a good hand-lens one can always separate these two species at a glance when the characters have once been fixed in mind. (See Figs. 31-*72* and *73* and compare Fig. 31-*66* and *68*).

Larvæ were taken almost continuously from mid-June to mid-August and probably occurred before and after these dates. The duration in the larval stage appears to be about two weeks.

Puparium (Fig. 31-*78*). Length, exclusive of respiratory process, about 5.3 mm., height about 2 mm., width about 2 mm. In general shape, color and appearance so similar to *A. obliqua* as scarcely to permit of separate description. The puparium is generally less strongly elevated on the posterior part. The characters of the posterior respiratory appendage, however, remain as in the larva and will always serve to distinguish these two species.

Puparia were taken from June 30 to August 7. In all cases these were found glued by the posterior part of the venter to the leaves of the host plant. The duration in the pupa stage ranged from 5 to 9 days.

Adult (Fig. 31-*71*). The following description adopted from Williston (62, p. 105) applies to the adults reared from the above described larvæ and pupæ. Length 6 to 8 mm. ♂. Face and front light yellow, shining; tubercle somewhat fuscous. Antennæ reddish yellow. Dorsum of thorax dark greenish olivaceous with a yellow lateral stripe, indistinct or wanting back of the suture. Pleuræ with light yellow spots as shown in Figure 31-*71*. Scutellum sulphur yellow. Abdomen slender, second segment with a broad yellow cross-band in the middle, and a brown or black band in front and behind, not reaching the lateral margin. Remaining abdominal segments variable, third with a broader yellow band and more narrowly brown or blackish in front and behind. Hypopygium wholly reddish-yellow, globose, with a tuft of pile below in front. Legs yellow including the coxæ.

♀. Front shining black, yellow on the sides below; yellow lateral stripes of thorax extending only to the suture. Abdomen moderately broad, shining black, with the extreme lateral margins continuously yellow and a moderately arcuate, entire, yellow band, reaching the yellow on the sides, on each of the segments from two to four inclusive. These bands cover about one-third the length of the segment. Fifth segment with a similar but slenderer yellow band interrupted in the middle. Sixth segment yellow with some black on the disk. In other respects as in the male.

Allograpta obliqua Say.

(See also 33, p. 533 and 35, p. 58.)

This species which ranges throughout much of this country and is often common, was very rare about Orono during 1915, being represented in the collections by a single male taken about blossoming cabbage, July 29. The immature stages were not encountered. However, on account of its close resemblance to *Sphaerophoria cylindrica* and *Melanostoma mellinum,* and the certainty that it does occur here, the following brief descriptions are included from the author's Ohio report (33).

Egg. (Fig 31-*61*, *62*, *63*). Elongate oval in outline, narrowing to the roundly-pointed anterior end and the truncate micropylar end. Length about .8 mm., diameter about .3 mm. Color chalk white, with the usual microscopic sculpturing (Fig. 31-*63*). The main bodies of the elevations are broader than in *Syrphus americanus,* three or four times as long as broad; sub-oval, the arms thicker and shorter than in *S. americanus,* usually about fifteen around each body. The depressed space between the bodies about two-thirds as wide as the body. About 28 of these elevated bodies the length of the egg; about 55 around it at the middle.

Larva. (Fig. 31-*65*, *66*, *67*, *68*). When just hatched (Fig. 31-*65*) the larvæ have a length of 1.2 mm., width .25 mm. They are irregular in outline, nearly cylindrical, broadest near the middle; feeble and inactive. Color whitish, with a yellowish or greenish tinge. The usual small, fleshy, conical, segmental elevations are present, twelve to each segment, but no bristles were discernible on them. The posterior breathing appendages are rather prominent, longer than in a young larva of *S. americanus,* and light in color like the rest of the body. Their tips are, at first, rather remote from each other though with subsequent growth and their greater elevation above the general body surface they become contiguous. The two longitudinal fat bodies are discernible as a white line on each side of the dorsal blood-vessel which is more prominent in the posterior half of the body. The skin is faintly wrinkled transversely.

From this condition there seems to be a gradual growth until the larva, when full-grown has reached a length of about 8 mm., width 2 mm., height 1.25 mm. It may then be described as follows: Shape elongate oval, but much more pointed at the anterior end when extended The outline is somewhat irregular due to folding and wrinkling of the skin. The posterior end is rounding, truncate except for the projections of the posterior breathing organ; (Fig. 31-*66*).

Color green, with two longitudinal white stripes. This color is due to colored visceral bodies which show through the transparent skin. Along the mid-dorsal line for two-thirds the length can be seen the narrow, dark, pulsating blood-vessel. It is irregularly limited at the sides by a narrow mass of greenish, fatty globules changing gradually to whitish. This whitish adipose matter forms the two prominent longitudinal white stripes, .2 or .3 mm. wide and extending to within a few millimeters of either end where they become much attenuated. The rest of the body, except the appendages is green, darker on the sides. The breathing tubes are light brown, black at the tips where the spiracles are located.

The skin is finely papillose when magnified, bare except for the segmental bristles which are light in color, not elongate and not conspicuous. The outer pair of mouth-hooks (Fig. 31-*67*, *c*) is present. The posterior respiratory appendage is prominent, elongate, about .5 mm. in length, .33 to .4 mm. in breadth and a little less than .2 mm. in height; the two fused tubes diverging slightly at the extreme tip (Fig. 31-*66*, *c*; *68*). The median spiracle .08 to .09 mm. long, about .015 mm. broad, the carina bearing the spiracle about three times as long as broad. The circular plates about .05 mm. in diameter, their inner margins about .08 mm. apart. There is a short, but distinct, spur-like nodule on each interspiracular space, which is continued down the side of the tube as a more or less evident ridge.

Puparium (Fig. 31-*69*, *70*). Dimensions, average of eight: Length about 5.25 mm., maximum breadth 2.5 mm., maximum height 2.3 mm. This neglects the breathing tubes at the posterior end of the body which may project .5 mm. farther posteriorly or be directed more dorsally.

The puparium is broadest and deepest in front of the middle, the anterior end bulbous; strongly and evenly depressed and compressed to the posterior end, the posterior elevation very gradual. (See Fig. 31-*69* and *70*).

The color in this stage changes very decidedly during the development of the nymph within the translucent puparium. The color being due almost entirely to the inclosed matter is consequently at first the color of the larva—light pea-green with a brownish remnant of the dorsal blood vessel and, at the sides of this, the two whitish lines. The flattened posterior end of the puparium, including the breathing tubes, however, is light testaceous brown, the tips about the spiracles black. Midway on the length of the breathing appendages is a dark brown ring.

As the pupa develops within, the color changes, gradually losing all trace of the green and assuming more and more the colors of the adult. The first thing to be noticed is the reddish brown color of the eyes replacing the green in the anterior third of the pupa. Later the black and yellow abdominal markings become apparent.

The puparium is smooth, bare; the segmental spines inconspicuous. The breathing tubes as in the larva, prominent sub-cylindrical. The wrinkles of the skin often remain rather prominent.

Adult. (Fig. 31-*64*). Description after Williston (62, p. 96). "♂. ♀. Length, 6 to 7 mm. Face yellow, often with a bluish reflection, slightly brownish on the tubercle. Frontal triangle yellow; front in the female shining black on the vertex, continued as a broad stripe (broadest below) to the antennæ; on the sides the yellow of the face continues up along the eyes nearly to the ocelli. Antennæ reddish-brown, blackish on the upper part of the third joint. Thorax deep shining green, on the sides with a yellow stripe reaching from the humeri to the suture, where it is sharply truncate; post-alar callosity also yellow. Scutellum wholly light yellow, faintly reddish on the disk; pile black. Abdomen black or brown; first segment, except a slender transverse spot on each side behind, yellow; second segment with a slender yellow anterior fascia, and a broader one in the middle, about a third of the width of the segment; straight and but slightly widened at the sides; third segment with a broad arcuate band, not quite touching the posterior angles on the sides; fourth segment with two slender parallel stripes, leaving a slender black stripe between them, on each side a broader, oblique, oval spot, touching, or narrowly separated from the anterior end of the yellow longitudinal stripe, and reaching to the posterior angles; fifth segment similar, but the side spots less oblique. Legs light yellow; last three joints of all the tarsi, the hind tibiæ, except the base and a middle ring, and a ring on outer part of hind femora, brownish. Wings hyaline, veins black."

SYRPHUS AMERICANUS Wiedemann.

(See also 32, p. 477 and 35, p. 55.)

This American Syrphus-fly apparently ranges throughout North America and ranks along with *Sphaerophoria cylindrica* as one of our most valuable predaceous forms. The larvæ have been found preying on the following aphids in this State: *Aphis pomi* on apple; *Pterocomma flocculosa* on willow; *Symdobius oblongus* on white birch; *Aphis spiraecola* on spiraea; *Schizoneura lanigera* on apple and *Microparsus variabilis* and *Chaitophorus viminalis.* The larvæ were common during late July and early August. Pupæ were noted July 29 to August 2, the adults emerging ten to eleven days later. The office records show that larvæ, pupæ and adults occur in the State almost continuously from mid-June to mid-September at least.

Egg. (Fig. 32-*41*, *42*, *43*). Elongate-ovate in outline, sub-cylindrical, narrower and truncate at micropylar end, nicely rounded off at the opposite end, broadest in front of the middle (Fig. 32-*42*); somewhat flattened to the surface to which it is attached, slightly humped or rounded up above (Fig. 32-*41*). Length about 0.9 mm., diameter at middle about 0.3 mm. Color chalk white.

The sculpturing of the chorion consists of microscopic projections of the surface arranged in lines running longitudinally-obliquely around the egg. Each projection consists of a long, slender, irregular body (seven or eight times as long as broad) sometimes bent, with about twelve to twenty slender arms reaching out in all directions from it. The space between these bodies is roughly a half wider than the body itself. Into these spaces the arms project, most of them meeting similar projections from the same or another body, many branching so as to form a delicate network of slender white arms between the larger bodies. Figure 32-*43* is a fair representation of a small part of the surface of the egg-shell, highly magnified. The projections are chalk white, the depressions between them shaded, appearing grayish or yellowish. The bodies are of such a size that one may count about 25 the length of the egg and about 50 around it, transversely.

Larva. (Fig 32-*45*, *46*, *47*, *48*, *49*, *50*). Just after hatching (Fig. 32-*45*), length 1.2 mm., width .2 mm. to .3 mm. Shape sub-cylindrical, broadest at the posterior end, narrowing evenly to the anterior end, not enlarged in the middle. Color light yellow or with a greenish tinge. Body surface wrinkled, the sides irregular. *Segmental spines on the fourth to eleventh segments, inclusive, and the dorso-lateral ones on the third segment, very long, slender, black; giving the young larva a very hairy appearance, so far as I know characteristic of this species.* The posterior breathing appendages short, slightly divergent (Fig. 32-*45*, *a*). No integumental vestiture. Dorsal blood-vessel faintly discernible in the posterior half of the body. During subsequent growth these slender segmental hairs are replaced by shorter, stouter, more spine-like bristles; the posterior breathing appendages are slightly elevated becoming united on the median line; and minute black spines appear all over the dorsal surface of the body.

Mature larva.: Length about 11 mm., width about 2.5 mm., height about 2 mm. (Fig. 32-*46*). Compared with many other aphidophagous larvæ this species is noticeably elongate, slender, with more nearly parallel sides. Segments 6 to 11 of nearly equal width, the twelfth narrower and much depressed. Anterior to segment six the body tapers evenly to the mouth-parts when extended, or rounds off at segment four when at rest, with the head segments retracted. Body-wall prominently wrinkled and with the usual two longitudinal carinæ at each side. General color yellowish, or salmon-brown, marked with black and white. The whitish markings consist of a transverse, rectangular bar on each segment, from six to eleven, and a narrow line along each side of the larva in the dorsal lateral carina. Interrupted by the transverse white bars at each segment, is the mid-dorsal heart-line, consisting of six elongate, wedge-shaped, black marks, broadly margined with brown. Laterad of the brown are other prominent black blotches extending obliquely outward and back to the whitish lateral carinæ. The anterior two or three segments unmarked with black or brown, light greenish-yellow in color. The amount of brown color variable, frequently covering the entire dorsum except the heart-line in segments ten to twelve.

The entire dorsum of the larva covered with short, close-set, black, integumental spines. The segmental hairs larger but light in color and not conspicuous, situated on slight elevations.

The posterior breathing appendages on the dorsum of the last segment, (Fig. 32-*46*, *c; 49;* and *50*) are short (0.2 to 0.25 mm. long) and nearly twice as broad (0.4 to 0.5 mm.); divergent for half their length; the dorsal spiracular spines (Fig. 32-*49* and *50*, *a*) moderately long, sharply conical, with a very small lateral sub-basal spur. The six elongate spiracles (*b*) are irregularly and considerably curved, about 0.2 to 0.25 mm. long, the median one on each side nearer to the ventral than to the dorsal one.

The anterior prothoracic spiracles on the third segment (Fig. 32-*46*, *b; 47*, *a*) are small,, subcrescent shaped, the lip of the spiracle marked by nine rounded, tooth-like lobes, (Fig. 32-*48*).

The mouth-parts (Fig. 32-*47*, *c, d, e*) consist of the usual pair of beak-like jaws (*c, d*) and three pairs of mouth-hooks (*e*). The jaws are Λ-shaped, sharp, slightly hooked at the tip, somewhat shorter than usual, the dorsal extending slightly beyond the ventral when apposed. The latter has a ventrally projecting basal spur on each side. The mouth hooklets are unequal in size the outer pair largest; the other two pairs are situated close beside the jaws, the dorsal ones heavier, the ventral pair small, slender.

Puparium. (Fig. 32-*51*, *52*, *53*, *54*, *55*, *56*). Dimensions, average of 15: Length 6.5 mm., height 2.5 mm., width 2.6 mm. The head segments of the larva are retracted ventrally so that segments 3 to 5 lie at the anterior pole and the tip of the mouth-parts (terminal in the larva) are about 0.5 mm., back on the ventral side. The wrinkling of the skin, characteristic of the larva is largely lost, due to the inflation. The vestiture remains as in the larva, the segmental spines inconspicuous, but the exposed parts of the wrinkles of the larva, densely covered with very small, short, sharp, black spines. Sometimes this gives a rather prominent transverse banding of black where the spines are thickest.

The posterior three segments are proportionately less inflated than the middle ones. Shape from dorsal aspect ovate with the last segment and its respiratory appendage projecting; very slightly broadest in front of the middle, nicely rounded out in front. From the side (Fig. 32-56) the anterior and dorsal inflation is evident; the puparium is not strongly elevated posteriorly, being convexly depressed gradually from about the middle. From in front the puparium appears nearly circular in outline, very slightly flattened ventrally.

Color of the puparium, empty: pale brown, transparent; with pupa enclosed: variable, darker brown, strongly tinted with salmon. A day or two before emergence the prominent colors of the adult become plainly visible.

Adult. (Fig. 32-44). Description after Wiedemann (61) and Osten Sacken (39, p. 145).

♂. ♀. Length 8 to 10 mm. Female. Face yellow, in certain positions with a pearly luster, *with a brown stripe* in the middle, which begins at the oral margin but does not reach the antennæ; the latter brownish-black, reddish on the underside of the third joint. Cheeks blackish, *but separated from the mouth by a narrow yellow border,* which on the underside of the mouth completely cuts off connection between the black color on both sides. Front brownish bronze color, powdered with yellow on each side. Immediately above each antenna there is a brownish spot sometimes continued above into an indefinite black stripe; vertex metallic bronze or black, eyes bare. Thorax metallic greenish black, unstriped; with scattered luteous pile; on the sides, in front of the base of the wing, yellowish; elsewhere metallic green; scutellum metallic yellow, with a bluish reflection and sparse yellow pile. First abdominal segment metallic blue; the rest of the abdomen black with bright yellow cross-bands. The first abdominal cross-band is not interrupted but co-arctate in the middle; its ends do not touch the margin of the abdomen, but are separated from it by a narrow black border; sometimes a brownish mark in the middle of this band gives it the appearance of being sub-interrupted. The second cross-band is nearly as broad as the black cross-band between it and the next yellow band; it is usually perfectly straight (in some specimens the hind margin is gently sinuate); its ends do not touch the lateral margin of the abdomen; they are cut obliquely, forming a sharp angle anteriorly, and a rounded one posteriorly; the former almost touches the margin of the abdomen. The third band is similar to the second, only its hind margin is more perceptibly arcuated. The posterior margin of the fourth segment has as usual, a narrow yellow border; the fifth likewise, and two yellow spots at the base besides. Femora yellow; the four anterior ones in some specimens brownish at the extreme base only; the hind pair with a more or less distinct brown ring on the distal half; four anterior tibiæ and tarsi yellow; the hind tibiæ sometimes with a brownish ring, the hind tarsi brownish.

Male (Fig. 32-*44*). Front yellow, with a more or less distinct brown spot above each antenna; cross-bands on the abdomen broader than in the female, and distinctly broader than the black interval between them; posteriorly, they are often nearly straight, sometimes distinctly arcuate, especially the third band. The yellow spots on the second segment are not coalescent, but separated by a narrow black interval (in some specimens sub-coalescent); the fifth segment is yellow, with a black spot in the middle. The four anterior femora are black at the base; the hind femora are usually black, with a yellow tip; sometimes there is a trace of yellow at the base; hind tibiæ usually with a brown ring in the middle.

SYRPHUS TORVUS Osten Sacken.

(See also 30, p. 341 and 35 p. 57.)

Common to abundant throughout June and first half of July; rare during late July and throughout August. Reared from among *Aphis spiraecola* on spiraea and *Phorodon humuli* on plum seedlings. Hundreds of adults were noted about these colonies, feeding on the honey-dew secreted by the aphids. One male in the collection bears the label: "Hibernating puparium under leaves, Houlton, Maine, May 7, '07."

Larva (Fig. 33-*10, 11, 12, 13*). Length, 10 to 12 mm., width 3 to 4 mm., height about 2 mm. Shape sub-cylindrical, tapering rapidly in front to the mouth-parts, slightly narrowed but blunt and emarginate at posterior end; integument raised into numerous transverse folds continued laterally into a distinct longitudinal keel on each side (Fig. 33-*10*). First three body segments small, retractile, gradually thicker; next eight sub-equal; terminal segment flattened, bearing on its dorsal surface the posterior respiratory process (Fig. 33-*10, b; 13*). The spiracles narrow, elongate, nearly straight. The interspiracular ornamentation of slightly elevated, inconspicuous ridges. Circular plate dorso-mediad. Mouth-parts (Fig. 33-*11*) with a prominent pair of lateral mouth-hooks (*c*). Between the second and third segments dorsally is a pair of small brownish anterior spiracles (Fig. 33-*10 a, 11 g*); conical, the semicircular slit guarded by seven rounded teeth (Fig. 33-*12*).

The general color of the larvæ is brown pink. The integument is tough but transparent; naked but very finely papillose. The black mid-dorsal blood-vessel is prominent and in the living active larvæ the blood may be seen pulsating regularly from posterior to anterior end. Laterad of this blood-vessel are two long yellowish bundles of fat, irregularly outlined, extending practically the full length and varying in width. At the approach to metamorphosis these adipose masses increase in extent sometimes covering nearly the entire dorsum except the blood-vessel. At times also the body fluid invades more or less the fatty bodies appearing as outlying pulsating pockets.

Puparium (Fig. 33-*14*, *15*). Length 8 to 8.25 mm., width 3.5 to 4.3 mm., height 3.75 to 4 mm. Testaceous brown, naked, smooth except for slight remains of the transverse wrinkling of the larva. Broadest in front of the middle, nicely rounded in front, descending rapidly at the posterior end to the projecting respiratory process.

Adult (Fig. 33-*9*, *16*). Length ♂, ♀, 10 to 12.5 mm. Description, slightly modified after Osten Sacken (39, p. 139).

Female (Fig. 33-*9*): Face and cheeks yellow, a faint grayish spot on the cheeks under the eyes. Front and vertex shining black with black pile; the front on both sides along the eyes with a broad border of yellowish pollen sometimes meeting the similar border of the opposite side. This pollen continues in dilute form down the sides of the face crossing narrowly beneath the antennæ. Eyes pubescent (in many specimens the pubescence is very much rubbed off and very difficult to perceive). Antennæ inserted beneath a double arched ledge of front. The dark color of the front begins immediately above their root forming a blackish brown arch with a projecting angle in the middle. Antennæ dark brown; third antennal joint below and the bare arista sometimes more or less reddish. Face in profile perpendicular beneath the antennæ produced but little below the eyes, slightly concave beneath the antennæ to oblique tubercle, receding below (Fig. 33-*16*). Thorax dull greenish with but little luster; in well preserved specimens with three faint dorsal longitudinal darker stripes, divergent posteriorly; scutellum dull yellowish with a slight bluish reflection. The black pile of scutellum and dorsum of thorax changes to yellow on the sides of the latter where it is also much thicker and longer. Third longitudinal vein nearly straight; anterior cross-vein a third of the way from base to apex of the discal cell; anterior outer angle of first posterior cell acute. Entire sub-costal cell brown; root of wings as far as humeral cross-vein and the costal cell slightly tinged with brown. Legs slender; coxæ and basal third of femora black; on the hind pair the black reaches beyond the middle of the femora; hind tibiæ often with a brownish ring; four anterior tarsi brown the root of the first joint often reddish; hind tarsi dark brown.

Abdomen oval slightly broader than thorax; about twice as long; with three prominent yellow cross-bands, the first interrupted in the middle, all attaining the lateral margins. First segment entirely black; second segment with a yellow elliptical spot about the middle on each side prolonged usually as a narrow neck which reaches forward and touches the margin. Third and fourth segments each with a yellow cross-band on its anterior half, the hind margins of these bands very gently biconvex with a very shallow sinus at the middle; on each side the cross-bands are attenuated and curved forward so as to reach the anterior margin of the segment. The band on the fourth segment also touches its anterior margin in the middle, while that on the third is more remote from the anterior margin; the black interval between the bands is twice as broad as the bands. The fourth and fifth segments have yellow posterior margins, the fifth usually with two yellow spots on each side at the anterior margin.

Male. "Similar to the female but abdominal cross-bands broader, the biconvexity on their hind side stronger, and the sinus in the middle deeper; the gray spot on the cheeks under the eye often larger, sometimes occupying a considerable portion of the cheek; the brown ring on the hind tibiæ usually expanded so as to reach the tip of the tibiæ. The eyes (contiguous) are more distinctly pubescent, the front is beset with yellow pollen except a narrow black space above the antennæ."

SYRPHUS NITENS Zetterstedt.

Syrphus nitens Ztt. D. Scand. ii. 712 ♀, viii 3137 (Scaeva). Verr. Ent. M. Mag. v. 193; Brit. Fl. Syrph. 377, figs. 295, 296.

Larvæ of this European species, hitherto not recorded for North America, were found on the campus of the University of Maine, July 23 to August 11. Some of them were full grown on the former date, others only about half-grown on the latter date. They were taken among colonies of the Willow Grove Plant-louse (*Pterocomma flocculosa* Weed) on the branches of a willow tree. The aphids were very ravenously devoured. One larva under normal conditions was observed to destroy twenty-one of these large aphids in twenty minutes. Six empty, and one inhabited puparia were found glued to the small branches of the willow on July 26. The adult from this puparium emerged July 31. One of the larvæ collected July 26 pupated July 27 and emerged as adult (♀) August 6. Another pupated August 1 and emerged (♂) August 12. The duration in the pupa stage is therefore about 10 to 12 days.

Besides extending the known distribution of this species, this record is of particular interest because the larvæ are the only ones of the aphidophagous type I have seen in which the spiracles on the posterior respiratory process are not straight but remarkably convoluted (See Fig. 34-*3* and *4*).

Larva (Fig. 34-*1*, *2*, *3*, *4*, *5*). Length about 15 mm., width about 3 mm., height about 2.5 mm. An unusually slender, elongate species broadest about the eighth segment, but of nearly equal width from segment seven to eleven. The twelfth is nearly a third narrower and somewhat depressed, the posterior end squarish. Anterior to segment seven the body tapers evenly almost to a point at the mouth-parts, when extended; when at rest the anterior three segments retracted and rounded off at segment four.

In their natural habitat the larvæ were so covered with threads of flocculence from the aphid host as to appear light grayish in color. When this matter is removed the color is yellowish brown, considerably mottled with black. The most conspicuous black markings are due to masses of body fluids showing through the integument; but others are formed by particularly thick areas of the black integumental spines which cover the entire dorsum, but are so minute on the venter that the latter appears bare. The largest of these spines about .04 mm. long. The arrangement of these spots is shown in figure 34-*1*, where only the ones due to integumental spines are shown. There are nine such areas on each somite, three on the middle line and three at each side. The integument is folded transversely, there being about five folds to each somite on the dorsal side. On the ventral side in segments five to eleven, inclusive, are nude elevations suggesting prolegs. The segmental spines are situated on moderate, conical elevations and are about .10 to .15 mm. in length, but light in color. The head segments bear the antennæ and mouth-parts of the kind usual in aphidophagous larvæ. There is a pair of very heavy, black, lateral mouth-hooks. The anterior larval spiracles on the third segment (Fig. 34-*1*) are barely visible to the naked eye. When magnified (Fig. 34-*2*) the surface is found to bear about a dozen, elongate nodules arranged in a semi-circle.

The posterior larval spiracles are unique among aphidophagous larvæ so far observed. They are borne on a very short, double process rather more than usually emarginate distally, about half a millimeter broad, .25 to .33 mm. long and about .33 mm. high. *The slit-like spiracles instead of being nearly straight are remarkably and irregularly sinuate, convoluted or undulated in a very ornamental manner as shown in figure* 34-*3* and *4*. This extensive convolution makes the length unusually great for the spiracles in this type of larva. Between the spiracles the surface of the tube is deeply constricted so that each is situated along the summit of a broadly rounded carina, the most dorsal one the most prominent. The circular plate is only moderately conspicuous, about .055 to .075 mm. in diameter, their inner margins .08 to .1 mm. apart. The inter-spiracular ornamentation consists of small, blunt, rounded knobs sometimes double, entirely inconspicuous.

On several occasions larvæ of this species were noted extruding from the anus on the ventral side of the caudal segment, four finger-like flabellæ similar to those previously described for *Eristalis aeneus* (34, p. 86) but not heretofore noted among aphidophagous larvæ. Buckton (8) considers that these organs have a renal function.

Puparium (Fig. 34-6). The dimensions of ten specimens were as follows: The length ranged from 7.25 to 8 mm., with an average of 7.6 mm.; the width 3.5 to 4 mm., the average 3.75 mm.; the height 3.6 to 4 mm., the average 3.85 mm. The puparium bulbous in front, a little broader than high. The ventral line usually quite concave; the dorsal line well elevated, attaining its greatest height about mid-length. The greatest width about the anterior third, but diminishing very little either in height or width until within about 2 mm. of the posterior end; thence quite rapidly to the last segment which is commonly about one millimeter wide, half a millimeter high, and a millimeter long, uninflated. A prominent mid-dorsal carina, widening out anteriorly extends forward from the posterior respiratory process. The latter structure retains its larval characteristics. The color of the puparium is grayish-brown, with a mid-dorsal, broken, blackish line and an oblique lateral black stripe on the side of each segment due to the integumental spines. The segmental spines are easily detected, but remain inconspicuous because of their fineness and pale color.

Adult (Fig. 34-7). I reproduce Verrall's description of this species in full (55, p. 377), and append some brief notes on the Maine specimens.

"Eyes bare; abdomen ovate, with undulated entire yellow bands which scarcely reach the side-margins; thorax shining; antennæ considerably luteous but darkened above; anterior tarsi mainly yellowish."

"♂. Resembling *S. nitidicollis* but quite distinct; it is broader and flatter both on the thorax and abdomen. Face more blackish about the mouth-edge, until in dark specimens the whole mouth-edge, the jowls, and a middle facial line extending above the central knob are black; on the other hand the black may be restricted in a very pale specimen to a narrow mouth-edge and all the jowls; the pubescence on the face is usually more black, and the pubescence behind the eyes is deep orange instead of whitish as in *S. nitidicollis.* Frons almost always with blackish spots or lunules above the antennæ, but otherwise all yellow or orange, as is the face even up to the extreme top angle instead of being, as in *S. nitidicollis,* blackish grey on the upper part. Antennæ much darker than in *S. nitidicollis,* as they are at least darkened above the third joint, and usually have the whole of the upper part and end of third joint blackish or brownish as well as the upper part of the second joint, or occasionally the antennæ are altogether brownish with only obscure orange spaces beneath the joints; the third joint is distinctly longer than in *S. nitidicollis,* being on the inside much longer than deep after the end of the second joint; arista shorter and inserted farther from the base, with its basal joints more distinct, and after the basal joints more luteous and with a rather shorter thickened portion."

"Thorax brightly shining blue-black with deep orange pubescence. Scutellum with mostly black pubescence."

"Abdomen with more isolated and much more undulating bands, especially as regards the fore-margins of the bands on the third and fourth segments; the spots on the second segment are either isolated or only reach the side-margins at the upper corners, while the bands on the third and fourth segments do not quite reach the side margins and are beautifully undulated especially on the fore-margin; the hind margins of the fourth and fifth segments are less broadly orange; apparently the belly also gives a good distinction as *S. nitens* has isolated central black spots on the second, third, and fourth segments, while *S. nitidicollis* has only the hind margins of the third and fourth segments black; a very important character occurs in the marginal pubescence, which is all black after the basal corners, proving that normally the abdominal yellow bands do not reach the side margins and thereby thoroughly distinguishing it from *S. nitidicollis*."

"Legs quite distinct, as the basal two-fifths of the anterior femora and the basal four-fifths of the hind femora are black; the anterior tarsi have the three middle joints darkened, while the hind tarsi are usually more blackish. Pubescence behind the anterior femora almost all black."

"Wings less orange hued, the whole wing and especially the front part being more smoky."

"♀. Similar to the male, but also differing from *S. nitidicollis* by the undulating abdominal bands, darker antennæ, and flatter more ovate shape. Vertex brilliant purple, which is extended forwards down the middle of the frons for a short distance, which is more obvious when viewed from in front but which leaves the front half of the frons much more yellowish than in *S. nitidicollis;* the dark spots or streaks above the antennæ are small and sometimes inconspicuous; the mouth-edge is usually black, but there is only a trace of the middle facial line."

"Thorax brilliantly shining."

"Abdomen more ovate than in *S. nitidicollis,* with the basal pair of spots less sharply triangular, while the undulating bands are broader and may just indistinctly touch the side-margins at their upper corners, though not enough to cause pale marginal pubescence; the peculiar ventral spots seem very much as in the male."

"Legs paler than in the male, as in the original specimen upon which the species was introduced as British they are entirely orange down to the base of the femora, but usually the basal fifth of the anterior, and the basal two-fifths of the hind, femora are black; tarsi as in the male."

"Wings rather more orange than in the male................. Length about 10.5 mm............Rare."

In the Maine males the face across the knob with a black stripe, abbreviated much short of the base of the antennæ, prominent in all except one specimen. This stripe is continuous with the narrow black margin of the anterior mouth-edge. The latter black stripes turned obliquely outward toward the eye, cutting off a small, triangular, yellowish spot next the mouth edge before the jowls which are again all black and across behind the mouth. Pubescence behind the eyes whitish below, orange above.

Spots on the second abdominal segment in most specimens quadrangular rather than triangular. All the yellow bands distinctly separated from the side margins. The bands on the third and fourth abdominal segments, in both male and female, on the middle line, with a small anteriorly and posteriorly directed pointed projection, not shown in Verrall's figure 296.

The anterior femora are black on the basal fourth, the hind femora on a little more than the basal half.

In the females the lunate, black spots above the base of the antennæ are rather prominent and, in one specimen, almost continuous with the widened black extension from the vertex. The black stripe over the facial knob is present but the stripes across the cheeks not developed, the latter yellow to the jowls.

Hind femora entirely yellow the anterior ones black on about the basal sixth. The third joint of the antennæ in both sexes only a little longer than deep after the end of the second joint.

DIDEA FASCIATA Macq. var. FUSCIPES Loew.

(See also 30, p. 337, 34, p. 90 and 35, p. 58.)

This species which in Ohio I have found breeding only on *Longistigma caryae* infesting sycamore and basswood, was found among the Willow Grove Plant-louse (*Pterocomma flocculosa*) on the University of Maine campus the last of July and first of August, at which time most of the larvæ were full grown. Pupation took place about August 10. Adults were captured July 15 about infested twigs of green apple aphis (*Aphis pomi*).

The following descriptions are abbreviated from my previous publications on this species (30; 34, p. 90; 35, p. 58).

Egg. (Fig. 29-5). Of about the usual shape; broadest about the middle. Length 1.3 to 1.7 mm., diameter 0.4 to 0.6 mm. Color chalk white. The chorion is sculptured in a characteristic manner. The projecting bodies are close together, not highly elevated, each one two to four times as long as broad. There are 55 to 60 of these bodies lengthwise of the egg and 80 to 100 around it at the middle. The egg of *Didea* differs from all the others I have seen in that the projecting bodies are not smooth on the top but each one has a small number (6-10) of more or less angular, irregular-shaped, pit-like depressions hollowed out of it. These are so arranged as to leave between them an elevated part of the body with more or less parallel sides. The whole effect is to give the arm-like network appearance over the elevated body somewhat like that between these bodies, without the outlines of the bodies being obscured. The arms between these bodies are irregular, slightly branched, for the most part rather short, sometimes long, from 10 to 15 radiating from each body.

Larva (Fig. 35-*2, 3, 4, 5*). Length, 12 to 15 mm., width 5 to 6 mm., height 3 to 4 mm.; testaceous brown; flattened, sub-cylindrical, blunt at the posterior end, tapering and obtusely pointed in front when extended (Fig. 35-*2*). The head segments usually much retracted giving to the anterior end a bluntly rounded appearance. Each of the body segments, except the first two and the last, with several transverse folds of the integument and a transverse row of twelve segmental bristles each about .15 mm. long. The median and dorsal ones crown the summits of conspicuous, conical elevations which, like the rest of the dorsum, are close-set with short, radiating, black, integumental bristles about .065 mm. long. The transverse body wrinkles are continued laterally into distinct V-shaped prominences bearing the dorso-lateral segmental bristles and forming a zig-zag longitudinal carina along each side of the body. The lateral segmental bristle is situated at the apex of a similar cone or V underlying the dorso-lateral; and in front of it a small ventrally-directed fold bears the two ventro-lateral segmental bristles on smaller spiny prominences. The lateral border has thus a very irregular outline of sharp angular projections.

Mouth-parts with three pairs of small thorns close beside the V-shaped jaws. The prominent lateral mouth-hooks, found in so many aphidophagous species, wanting.

In the middle of the third segment is a pair of anterior spiracles. These are light brown, conical, with a semi-circular slit near the apex (Fig. 35-*4*).

On the dorsum of the last segment is situated the posterior breathing organ (Fig. 35-*2, b; 5*). This consists of two closely apposed, short, cylindrical breathing-tubes, united along the middle line, slightly divergent at the tip. They are hard, black, firmly chitinized structures, each with three slit-like spiracles raised on radiating carinæ. Dorsad near the middle line each is marked by a smooth circular plate about .09 mm. in diameter, their inner margins about .175 mm. distant from each other. The surface of the stigmal plates between the spiracles is very much roughened the inter-spiracular ornamentation consisting of thin laminate ridges, about as high as the carinæ, on which the spiracles are located; only the summits of these ridges are indicated in figure 35-*5;* about two such ridges on each interspiracular space and continued down the sides of the short tube. The median spiracle at least .25 mm. in length and slender.

The integument of these larvæ is exceedingly tough but transparent. The entire dorsal and lateral surfaces are beset with numerous, minute, short black bristles. The ventrum is bare. Along the mid-dorsal line for the greater part of its length the dorsal blood-vessel is visible through the body-wall. It is a poorly-defined, dark line with five or six lateral expansions.

As the larva approaches metamorphosis the anterior segments are retracted, the skin becomes inflated filling out the wrinkles characteristic of the larva. It rounds out anteriorly and dorsally, the point midway between the fourth and fifth segments coming to lie at the anterior pole, the mouth being shunted backward on the ventral side. The pupa is concealed in this indurated, inflated, sub-ovate, larval skin or puparium.

Puparium (Fig. 35-*6*, *7*). Length 9.5 to 10 mm., width 4.5 to 5 mm., height about 4.5 mm. Color, Roman sepia, a little darker than the larva. Broadest a little back of the sixth larval segment, nicely rounded in front, tapering gradually to the last segment which remains somewhat flattened, especially at the sides. The covering of small black bristles is retained and the black conical prominences become even more conspicuous owing to the inflation (Fig. 35-*6*, *7*). The posterior breathing appendages retain the larval condition.

Adult (Fig. 35-*1*). Description slightly modified from Williston (62, p. 89). ♀ ♂ Length 11-15 mm. Face yellow, with a small elongate brownish spot on the tubercle. Front yellow, with two brownish spots above the antennæ, or, in the female, with an inverted V-shaped brown stripe connected with the black of the upper part of the front. Eyes bare. Orbits thickly yellowish pollinose, posteriorly with a fringe of yellowish-whitish pile. Antennæ black, the third joint at the base sometimes reddish, elongate oval, obtusely pointed at the tip; arista reddish. Thorax shining greenish black, on the meso-, ptero-, and sterno-pleuræ yellow, thickly covered with similar colored pollen and pile. Scutellum light yellow, translucent. Wings grayish hyaline, the base before the humeral cross-vein and the stigma brown; the remainder of the subcostal cell and the costal cell may be brownish; third vein rather deeply curved near the middle of the first posterior cell. Legs brown, the posterior tibiæ and all the tarsi blackish; sometimes the legs are luteous, the base of femora, distal portion of tibiæ, and the tarsi brown. Abdomen black, with four yellow cross bands, the first consisting of two large ovate spots, narrowly separated and reaching the lateral margins in nearly their full width; second and third cross-bands broad separated from the lateral margins by a black narrow keeled border; they are much narrower in the middle of the segments, the front margin straight, touching the anterior edge of the segments; fourth band similar, but much smaller and attaining the margin; all the black is velvety opaque except the narrow posterior margin of the segments which is shining, dilated in the middle.

TROPIDIA QUADRATA Say.

This common, widely distributed species has been well known for many years, but no record has been made of the larval habits of this or any other species of the genus. No record had been made of its immature stages previous to the description by Mr. J. R. Malloch in December, 1915 (28, p. 343), of the *puparium* which was found floating on the water of a lake. The larval habit was not determined.

On July 7, 1915, at Orono a larva of this species was collected in partially decomposed human excrement near the mouth of a sewer. It was apparently full grown by July 19, pupated between the 21st and 27th and emerged from the puparium August 6.

On July 10 a gravid female was captured at the same spot and enclosed with a male over a small mass of the moist excrement. By one o'clock of the same day a mass of several hundred eggs had been deposited by this female. By July 14, 7 A. M., nearly all of the eggs had hatched and the young larvæ were submerged except for the posterior respiratory appendage in the moisture at the bottom of the jar. The larvæ were kept in cages and were about full grown on September 9. Three hundred and eighty-seven eggs were dissected from the ovaries of a female taken about human excrement on July 21. On July 27 seven puparia were taken from the drier parts of the mass of excrement. One of them which had apparently just pupated emerged August 8; others from July 28 to August 1.

Egg. (Fig. 36-*1*, *2* *3*). Sub-cylindrical, elongate-ovate in outline, a little smaller and more truncate at the micropylar end, slightly curved on its long axis. The length of specimens measured varied from .82 to .86 mm., with an average of .84 mm; the maximum diameter was very uniformly .255 mm. Color white, glistening. The markings or sculpturing of the chorion (Fig. 36-*2*) are characteristic, although approached closely by *Syritta pipiens* (See p. 253). It consists of small, irregular, polygonal areas, which are slightly raised, leaving between them narrow, parallel-sided and rather smooth-sided channels; the latter connecting with each other to make a fine dark network over the surface of the egg. Each of the areas thus marked off is further ornamented on its surface with about 20 to 40 circular areoles by the slight depression of the surface between them. When viewed under very high power (oil-immersion objective and 3-4 inch ocular) the minute circular areoles are seen to be formed by the arrangement of very fine finger-like elvations, (Fig. 36-*1*).

The polygonal areas are of such a size that about thirty occur end to end the length of the egg and about fifty or sixty side by side around it.

Egg-laying was observed from July 10 to July 21; but, since a good-sized larva was found as early as July 7 and since adults continued to emerge at least until August, the egg-laying period is doubtless much more extended. In the case observed (laboratory) the egg-stage lasted between 72 and 90 hours.

Larva (Fig. 36-4, 5 6, 7). At a very early stage (2 or 3 mm. long) the young larva shows the characteristics of the full grown one, seemingly differing only in size. Full grown larva about 16 mm. long; maximum width 3.75 mm., maximum height 3.5 mm. Nearly cylindrical, broadest in the middle; the anterior segments forming a globose, false head; the posterior segments tapering rather rapidly throughout the caudal eight (about 2 mm.) of the length to the posterior respiratory appendage. The latter structure terminal; about .75 mm. long, .66 mm. broad at its base, .5 mm. broad at its apex, and about .4 mm. high. The double nature of the appendage indicated by moderate impressions on the mid-dorsal and mid-ventral lines.

The distal end is truncated, and the stigmal plates ornamented with a pair of circular plates, three pairs of spiracles and four pairs of palmately-divided, plumose, interspiracular hairs. The circular plates occupy nearly a median position, dorso-ventrad, and are situated near the median line. Each has a diameter of .085 to .095 mm. and their inner margins are less than .02 mm. apart. The spiracles are roughly S-shaped, each ornamented with about twenty short, rounded, lateral denticles, irregular in size and irregularly distributed. The right median spiracle forms an S, the left one a reversed S. In other words the dorsal free end of the S on either stigmal plate is directed laterad, the ventral free end, mesad. The interspiracular ornaments consist each of about five plumose or feathered hairs arranged palmately. Some of the hairs are further divided; all are united at the extreme base; and occasionally two are united for some distance from the base.

Immediately cephalad of the posterior respiratory appendage at each side of the twelfth segment are three fleshy, conical lateral protuberances, the posterior one about .75 mm. long, the others about half that length, each pair connected by a prominent wrinkle across the dorsum of the segment. The first four body-segments composing about the anterior sixth of the body (2 or 3 mm.) is head-like globular, and separated by a slight neck-like constriction from the succeeding segments; with several faint longitudinal furrows on its sides. At the anterior end this false-head bears a pair of small antennæ, each of a fleshy base, surmounted by two, minute, sub-equal, rounded nodules side by side at its apex. Just ventrad of the antennæ is a rounded, somewhat-chitinized mouth-hood, concave ventrally, within which is the buccal cavity. The mouth opening further guarded by a fleshy fold at each side, covered with long flexuous hairs, of service in straining the food. The dorsal part of the bulbous false-head is ornamented with a characteristic group of black, chitinous hooks or thorns. There are two large hooks about .25 mm. long on each side, situated about one millimeter dorso-laterad of the mouth-hood, their bases about .35 mm. apart. Extending between, and dorsad, of them are three irregular, transverse rows of smaller and various-sized thorns, most of them barely visible to the naked eye. The most posterior of these rows (Fig. 36-7*A*) consists of a large thorn at each side and six to ten smaller ones between them. In the middle row near each side, and looking much like a thorn, is located the sessile, anterior larval spiracle (Fig. 36-7*B*). There is a small hook or thorn laterad of each spiracle, a large one mesad and, between the latter, about three smaller ones. The anterior row consists of six to ten thorns of moderate size. Cephalad of these three rows and above the mouth-hood is a semi-circular band of numerous microscopic hooklets. The surface of the anterior larval spiracle bears four rounded nodules.

The entire surface of the body is covered with microscopic, close-set, pale brown, short, soft hairs. The segmental hairs are longer flexible and about three in a clump. Eight transverse rows of them can be made out posterior to the anterior spiracles. The body segments are further indicated each by a group of about four transverse wrinkles. About seven pairs of prolegs, consisting of ventral fleshy projections, each bearing a clump of recurved hooklets; five pairs on segments five to nine, inclusive, about equally developed and with a dozen or more hooklets, the anterior ones largest; one pair on the venter of the third segment which usually has fewer hooklets, and a smaller pair on segment ten. The anus is a prominent transverse slit about 2 mm. cephalad from the base of the posterior respiratory organ, on the venter of the eleventh segment.

Color dirty white or clay yellow.

Under laboratory conditions the larval period extended over about two months from July to September. Although the larva has been found only in human excrement, there is no reason to believe it would not develop in other kinds of filth or decaying material.* The larvæ were found in the moist, but not watery, portions of the mass and several inches beneath the surface.

Puparium (Fig. 36-*8*, *9*, *10*). Pale brown. Length 8 to 9 mm; maximum width 3.25 to 3.75 mm.; maximum height 2.75 to 3.25 mm. Broadest a little in front of the middle where it is nearly circular in cross-section. Only a little narrowed and globose in front, but evenly tapering caudad to about one-third the width just in front of the posterior respiratory process. As viewed from the side, ventral line nearly straight to within about two millimeters of the posterior end, thence elevated; the dorsal line a little more strongly and abruptly elevated anteriorly than posteriorly.

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*Since writing this, I have found the larvæ and puparia at Presque Isle and Houlton, July 8 and 9, in masses of rotting potatoes which had beep swept out of store-houses and allowed to lie on the ground until well-decayed. Adults emerged from the puparia, July 19 and 20.

Many adults were noted hovering—apparently for the purpose of ovi-posting—about the above masses and also about decaying masses of "sprouts" from potatoes used in planting.

The anterior end bears, in addition to the characteristics remaining from the larval stage, a pair of pupal respiratory cornua situated well dorsad, their bases about .75 mm. apart (Fig. 36-*8A*, *10A*). Each cornuum strikingly like a common species of morel mushroom in appearance; about .4 mm. broad and .5 mm. long, the basal third or fourth slenderer. Its surface bears a hundred or more of minute papillæ each when very highly magnified (Fig. 36-9) showing a further ornamentation of its surface with five to eight nodules.

The buccal hood of the larva occupies a position at the anterior extremity of the ventral line (Fig. 36-*10C*), and although they are much less conspicuous, the arrangement of thorns and hooklets remains essentially as in the larval stage. For the emergence of the adult the anterior end splits into a two-piece operculum; one transversely elongate piece surrounding the pupal respiratory cornua; the other an ovate piece, cephalad of this and including the anterior larval spiracles, but not the two pairs of largest hooks. The posterior end of the puparium much as in the larva; the respiratory process terminal and, at each side of it, the three pairs of lateral processes of the body-wall, somewhat shrunken and indurated. Slight traces of the transverse wrinkling remain and on careful examination the larger hooklets of the prolegs can be distinguished.

The duration in the pupa stage was between 9 and 15 days, this stage being noted during late July and early August. The pupæ were found a few inches under the surface in the moderately-dry parts of the excrement in which the larvæ had fed. Pupation is accompanied by the induration of the larval skin with chitin and the great inflation especially of larval segments five to eleven.

Adult (Fig. 36-*12*, *13*, *14*). *Eyes bare, face with a median keel-like ridge, marginal cell open, third vein curved, anterior cross-vein beyond the middle of the discal cell; hind femora extraordinarily thickened with an angular projection below near outer end; abdomen of nearly equal width.*

Length 9 to 12 mm. Front in female narrow above; face gently convex in profile in the male, a little concave near the middle in the female; densely covered with yellowish gray pollen, leaving a slender median stripe and a spot on the cheeks black. Antennæ yellow, third joint nearly square. Dorsum of thorax shining, greenish black, with two rather distinct median pollinose stripes in front, two spots of the same colored pollen in front of the scutellum, another in front of each postalar callus, on the humeri, and a spot along the dorso-pleural suture immediately behind the humeri. Scutellum yellow along the border. First abdominal segment black, yellow on the sides; second segment in front (but not reaching the sides) and a narrow median stripe black, behind extending narrowly to the sides, more brownish, forming an inverted T; third segment with a similar T but more brownish, less distinct. In the female the black on the second segment is broader, the third segment black except a quadrangular spot in front on each side. Front and middle legs yellow, except on the basal half or more of the femora, black; hind legs black, the knees only yellow. Description adapted from Williston (62, p. 207) and Verrall (55, p. 571).

SYRITTA PIPIENS Linné.

This is one of our most abundant and wide spread species, apparently occurring throughout most of Europe and North America and common from spring to autumn. It has been recorded breeding in horse-dung and cow-dung in Europe (17), and Dr. L. O. Howard has noted the capture (but not the rearing) of an adult about human fæces.

The larvæ were found breeding in large numbers in moist masses of guinea-pig manure in the animal room at Ohio State University during the winter and spring of 1915. On July 7 at Orono, two puparia were taken from a drying mass of human excrement at the opening of a sewer. Adults emerged from them August 2 and 3. On July 7 and 12 a number of females were found hovering about the above-mentioned mass of filth. Two of them were enclosed in a vial and had soon deposited a mass of several hundred eggs. They began hatching on July 16, the duration in the egg-stage having been almost exactly four days.

This species in all its stages shows a close resemblance to *Tropidia quadrata* and it will be described in comparison with that species.

Egg. (Fig. 37-*1*, *2*, *3*). Sub-cylindrical, tapering toward the ends; the micropylar end somewhat truncate, the opposite end rounded out; nearly straight on the ventral side, somewhat rounded up dorsally. Dimensions (ten specimens): Length .6325 to .6875 mm., average .665 mm.; maximum diameter .213 to .24 mm., average .23 mm.

The sculpturing of the chorion consists of polygonal elevated areas, separated by narrow depressed lines which form a darker network over the entire surface. About thirty such elevations the length of the egg, fifty to sixty around it. With higher magnification (1-4 in. objective) these elevated areas are seen to be finely papillose, and on closer examination the papillæ are seen to be grouped into areoles of greater elevation, with depressions between them. As contrasted with *T. quadrata,* it is evident that the grouping of the papillæ into definite rounded areoles is much less pronounced and that the areoles are much more irregular in shape (Fig. 37-*2*; cf. fig. 36-*1*). For example on the egg of *T. quadrata* the areoles are quite easily seen with a 2-3 in.

objective; while in *Syritta pipiens* they are hardly made out with less than a 1-4 in. objective and are not as definite at any magnification. Color white.

Larva (Figs. 37-*4, 5, 9*). Superficially resembling the larva of *T. quadrata,* especially in the differentiation of the anterior segments into a false-head and in the possession of three pairs of lateral fleshy projections just anterior to the short, posterior respiratory process. It differs from *T. quadrata* in its much smaller size, in being less nearly cylindrical, broader in the median segments, and somewhat flatter; the posterior respiratory organ is relatively longer and slenderer and the constriction between segments three and four (at the side of the false head) more marked.

Length about 10 mm., maximum width about 2.75 mm., maximum height about 2 mm. Broadest in the region of segments seven to nine. Tapering moderately backward to less than half the width at the base of segment twelve; much more moderately toward the head. The false head 1.75 to 2 mm. broad, not as well developed as in *T. quadrata.* Color dirty yellowish. The entire integument covered with pale and delicate, close-set microscopic hairs, longer on the more exposed portions. The false head lacks the conspicuous hooks or thorns of *T. quadrata,* the vestiture being specialized only into the transverse band of microscopic hooklets above the mouth. Antennæ, mouth-hood and lateral mouth-folds not differing noticeably from *T. quadrata.* The false-head with about a dozen longitudinal furrows, one on the mid-dorsal line. The anterior larval spiracles located between the first and second furrow from the mid-dorsal line, sessile; each apparently with three rounded nodules on its summit. There are seven pairs of prolegs on segments 3 and 5 to 10, inclusive, the first pair situated more widely apart than the others, the last pair smaller, each with about two dozen hooklets of varying size.

The posterior respiratory organ is a brown, chitinized, polished tube, projecting about .75 mm. (.5 to 1 mm.) its width ranging from .25 to .35 mm., its depth from .2 to .25 mm. A little broader at base than at apex, the latter truncated. The tube is semi-transparent and the two large tracheal trunks can be seen throughout its length. The stigmal plates similar to those of *T. quadrata* but with distinct differences. The most important difference is that the three pairs of spiracles are less distinctly S-shaped and each is ornamented with from nine to fourteen (compared with about twenty for *T. quadrata*) of rounded lateral projections or denticles irregular in size and irregularly distributed.

Puparium (Fig. 37-*6, 7, 8*). Dimensions (15 specimens): Length, inclusive of the posterior respiratory appendage which retains the same dimensions as in the larva, 5.9 to 7.9 mm., average 6.8 mm.; maximum width 2.75 to 3.4 mm., average 2.95 mm.; maximum height 2.65 to 2.95 mm., average 2.68 mm. In outline elongate ovate, a little more attenuated posteriorly, this attenuation more pronounced than in *T. quadrata.* Nearly circular as seen from in front a little flattened on the venter. The ventral line as seen from the side, straight from mouth-parts almost to the posterior respiratory process before which it becomes a little elevated. The dorsal line begins with a very sharp, nearly rectangular elevation in front, followed by a gentle flexure reaching its greatest height a little in front of the middle. The descent is gradual throughout the third quarter of the length, thence more abruptly to the posterior respiratory organ.

The pupal respiratory processes (Fig. 37-*6A, 8*) penetrate the puparium near the antero-dorsal flexure, about 2 mm. from the ventral line and half a millimeter caudad. Each measures .35 to .5 mm. in length, maximum diameter about .2 mm. Morel-shaped, the proximal half being somewhat more slender, the distal half dilated and studded with about seventy-five minute nodules. Each of these nodules when very highly magnified (Fig. 37-7) is seen to consist of four, five or six oval elevations each with a median slit. The anterior face of the expanded part traversed by a branching shallow groove. The clumps of hooklets on larval prolegs are conspicuous along the mid-ventral line and the posterior respiratory process retains its larval characteristics.

Adult (Fig. 37-*10, 11*). *A small slender, nearly bare, fly, black with yellow markings and very thick hind femora; marginal cell open, third vein gently curved, anterior cross-vein near the middle of the discal cell.* Description adapted from Williston (62, p. 240) and Verrall (55, p. 612).

Length, 7 to 8 mm. Face and front satiny yellowish white. Front of female narrow above, shining black, with two small pollinose spots; vertical triangle of male elongate. Antennæ reddish yellow. Dorsum of thorax black, nearly bare, in front with two approximate pollinose spots. The humeri and to the suture and all the pleuræ yellowish or whitish pollinose. Abdomen: opaque black in front, shining behind; narrow sides of first segment and a broad spot at each side of the second, yellow, somewhat whitish pollinose. "At the extreme produced base of the second segment a remarkable fringe of whitish hairs, ... the only obvious pubescence on the abdomen" (55, p. 613); third abdominal segment with a smaller yellow spot at each basal corner and the fourth with a narrow, interrupted yellowish-white pollinose cross-band, the hind margin narrowly yellow. In the female the spots smaller, the sides of the third segment in front metallic, scarcely at all yellow, but with a light pollinose spot. Legs yellowish-red with obscure brownish markings; hind femora black, with the base and a usually incomplete ring near the middle, reddish yellow; hind tibiæ at the middle and tip brown or black.

ARTIFICIAL KEYS TO THE KNOWN LARVAE AND PUPAE OF SYRPHIDAE

KEY TO TYPES OF LARVAE

1. Body terminating in a long, flexible and extensile, rat-tail-like respiratory appendage (often longer than the body). Larvae aquatic, semi-aquatic, or living in moist decaying materials. The puparium with a pair of prominent, anterior, respiratory cornua (See also p. 210) ....
IV. THE LONG-TAILED FILTH-INHABITING TYPE (Genera *Eristalis, Helophilus, Chilosia, Chalcomyia, Sericomyia, Mallota,* etc.)

Posterior respiratory appendage considerably shorter than one-fourth the length of the body, rigid. Habits various, but not aquatic larvae 2

2. Larvae short-oval or rounded in outline, convex above, and with a very flat, creeping-sole, ventrally, around which is a fringe of spines. The shape constant and sub-hemispherical; no evident transverse wrinkling of the body-wall, but the dorsum often nicely reticulated. Larvae living in ant-nests. The puparium sub-hemispherical, and with prominent anterior cornua. (See also p. 211) ....
....................V. THE MICRODON TYPE (Genus *Microdon*)

Shape of larva elongate-oval with the venter flattened, or sub-cylindrical; the outline not constant, but the body especially the anterior end, capable of considerable extension when active 3

3. Body nearly cylindrical, the anterior end not attenuated, but rounded out, forming a false-head. Three fleshy, finger-like processes at each side of the last body-segment. No external mouth-parts. Puparium with prominent anterior cornua. (See also p. 210) ....
III. THE SHORT-TAILED FILTH-INHABITING TYPE (See key below)

The anterior end of the body considerably attenuated, when active; no false-head. Black, chitinized mouth-parts present........4

4. Body nearly circular in cross-section. Mouth-parts of two recurved hooks, uniting basally into a mouth-hood. Stigmal plates with groups of minute, palmately-arranged, plumose hairs. (See also p. 209).....................................
.............II. THE BORING TYPE (*Merodon equestris* Fabr.)

Body always noticeably, often much, flattened. Mouth-parts of two, Λ-shaped jaws. Stigmal plates with various ornamentation but not with plumose hairs. Puparium rounded in front, attenuated behind, and apparently without pupal respiratory cornua (See also p. 208) ....
...............I. THE APHIDOPHAGOUS TYPE (See key below)

I. THE APHIDOPHAGOUS TYPE

Key to Species

1. Dorsal pair of slit-like spiracles much shorter than the other pairs, its carina rounded. Larvae phytophagous .... *Toxomerus politus,* p. 216.

All the slit-like spiracles elongate, at least several times as long as broad, or at least the dorsal pair not conspicuously shorter. Larvae aphidophagous 2

2. Posterior slit-like spiracles greatly elongate and extensively sinuate or undulate. (Fig. 34-*3*) ....*Syrphus nitens,* p. 242.

Posterior slit-like spiracles straight or somewhat curved, never much sinuate 3

3. General color greenish, with white longitudinal stripes. Rather smooth-bodied larvae with no integumental vestiture and the segmental spines not prominent 4

General color yellowish, reddish or brownish 6

4. Posterior respiratory organ less than half as long as broad. Slit-like spiracles less than twice as long as broad. Viscera usually plainly visible thru the skin. (Fig. 30-*5* and *6*) ....*Melanostoma mellinum,* p. 226.

Posterior respiratory organ considerably longer than broad. Slit-like spiracles each at least three times as long as broad.......5

5. Stigmal plates roughened, the spiracles well elevated and separated by spur-like elevations. The two tubes very slightly divergent at the tip. (Fig. 31-*66* and *68*) ....*Allograpta obliqua,* p. 234.

End of posterior respiratory appendage nicely rounded off, smooth, the spiracles not elevated, and not separated by perceptible spurs. The two tubes not at all divergent. (Fig. 31-*72* and *73*). ....*Sphaerophoria cylindrica,* p. 231.

6. Integument of the larva bare except for the segmental spines.....7

The entire dorsal surface of the larva covered with short, microscopic spines, black, or sometimes light in color and then not prominent 8

7. Posterior respiratory appendage longer than broad; inter-spiracular nodules rather prominent..*Syrphus xanthostomus* (34, p. 81).

Posterior respiratory appendage broader than long; inter-spiracular nodules not prominent. (Fig 33-*13*) ....*Syrphus torvus,* p. 240.

8. Segmental spines conspicuous or raised on prominent, fleshy or spiny, conical elevations easily seen by the naked eye 9

Segmental spines not prominent and not raised on conspicuous, conical projections; sometimes hard to distinguish from the integumental spines 11

9. All of the segmental elevations and segmental spines, on the dorsal surface of the body, of nearly equal size. The inter-spiracular spaces on the stigmal plates with lamellate, upright ridges. (Fig. 35-*2* and *5*) ....*Didea fasciata fuscipes,* p. 246.

The dorsal, segmental elevations (ones next the median pair) in the principal body-segments much reduced in size. The dorsal spiracular nodule long and prominent; the other inter-spiracular spaces with small nodules or delicate hairs........10

10. Posterior respiratory appendage broader than long ....*Paragus bicolor* (31, p. 397).

Posterior respiratory appendage considerably longer than broad. ....*Paragus tibialis* (31, p. 402).

11. Integumental spines black. Inter-spiracular spaces with short, stout, black spurs. (Fig. 32-*46*, *49* and *50*) ....*Syrphus americanus,* p. 236.

Integumental spines light yellow. Inter-spiracular spaces with long slender hairs. (Fig. 29-*2*) ....*Pipiza pisticoides,* p. 224.

III. THE SHORT-TAILED FILTH-INHABITING TYPE

Key to Species

1. False-head of larva without any conspicuous, black, anterior thorns or chitinized hooklets. Posterior respiratory appendage about three times as long as broad. The spiracles on stigmal plates with about ten lateral denticles. (Fig. 37-*5* and *9*)...... ....*Syritta pipiens,* p. 253.

Antero-dorsal part of false-head ornamented with black hooks or thorns, visible to the naked eye. Posterior respiratory appendage less than twice as long as broad. The posterior spiracles with more than fifteen lateral denticles 2

2. Two prominent hooks on each side of the false-head, their bases united into one chitinous plate. The posterior spiracles with forty to eighty lateral denticles........*Zelima* (*Xylota*) *pigra.*

Two prominent hooks on each side of the false-head, their bases separated by a little more than their length; also several transverse rows of slightly smaller thorns between these pairs. The posterior spiracles with fifteen to thirty lateral denticles. (Fig. 36-*5*, *6*, *7* and *8* ....*Tropidia quadrata,* p. 248.

Glossary of New or Unusual Terms.

Anterior larval spiracle: The breathing pore, or opening to the trachea, situated at the side of the third body segment of the larva (Figs. 34-*2*; 32-*46b;* and 36-*5B*).

Anterior stigmata: See anterior larval spiracle or pupal respiratory cornua.

Areoles: As applied to the sculpturing of the chorion or egg-shell, a minute differentiated spot on the surface of a *body* (q. v.).

Arm: As applied to the sculpturing of the chorion or egg-shell, a slender, root-like, elevated process from a *body* (q. v.), extending into the depression between the bodies.

Aschiza: (Brauer) a section of the dipterous sub-order Cyclorrhapha in which the frontal lunule and suture above the root of the antennæ are wanting. It includes the families Syrphidae, Pipunculidae, Platypezidae and Phoridae.

Body: As applied to the sculpturing of the chorion or egg-shell, a microscopic elevated area surrounded by a depression.

Carina: An elevated ridge; see dorso-lateral carina, ventro-lateral carina; and also under slit-like spiracle.

Circular plate: "Button" of authors: a usually smooth, or roughened, circular or oval area of the stigmal plate situated, typically, dorso-mediad on the latter; and usually distinct in color or texture from the rest of the stigmal surface; sometimes partially or completely surrounded by a ridge (Figs, 30-*5B;* 34-*3A* and 36-*6B*).

Cyclorrhapha: (Brauer) a sub-order of the Diptera in which the larvæ lack a differentiated head; the pupæ are always enclosed in the hardened larval skin or puparium, from which the fly escapes through a circular orifice or operculum at the anterior end.

Dorsal line: The upper margin of the puparium, when viewed from the side, extending from the position of the larval mouth-parts in front, dorsally around to the base of the posterior respiratory process behind.

Dorsal spiracular spine, ridge or nodule: A chitinous elevation of the stigmal plate mesad from the circular plate (q. v.) (Fig. 32-*50a*).

Dorso-lateral carina: An irregular, longitudinal, zig-zag ridge along the side of the body of the larva (formed by the fusion of the ends of transverse folds of the integument) above the ventro-lateral carina, and bearing the dorso-lateral segmental bristles of successive segments.

False-head: A globose grouping of the anterior segments of certain larvæ, partially constricted from the succeeding segment.

Integumental vestiture: Minute, close-set, short, microscopic hairs or bristles covering the integument of the larva at least on the dorsal surface; contrasted with the segmental vestiture (q. v.).

Interspiracular ornamentation, hairs, spines, spurs, nodules, ridges, or lamellae: Armature of various kinds occurring in the interspiracular spaces (q. v.). See also, dorsal spiracular spine.

Interspiracular spaces: The areas between and around the slit-like spiracles on the apex of the posterior respiratory process. These are four in number on each stigmal plate; one between the dorsal slit-like spiracle and the circular plate; one between dorsal and median spiracles; one between median and ventral spiracles; and one mesad from the ventral spiracle.

Jaws: Of aphidophagous larvæ, a pair of chitinized, Λ-shaped lips above and below the mouth-opening (Fig. 30-*4C*).

Jowls: The part of the head below the cheeks and the eyes (Wingate); also known as the cheeks or genæ.

Lateral mouth-hooks: Heavy, black, chitinized, curved hooks or thorns on the head segments but separated from the jaws by an intervening space, in which respect they differ from the mouth-hooklets (q. v.), as also in being usually shorter and broader at the base (Figs. 30-*4A*; 31-*67c*; and 33-*11c*).

Mouth-hood: A dorsally convex, ventrally concave, chitinous termination of the cephalo-pharyngeal skeleton of the larvæ of certain types, which covers the anterior opening of the alimentary canal. (Fig. 34-*7F*).

Mouth-hooklets: Chitinized, black, microscopic thorns, elongate and slender or short and thick, situated closely at the sides of the jaws and evidently of assistance in prehension (Figs. 33-*11d*; and 35-*3c* and *d*).

Posterior larval spiracles: See posterior respiratory organ.

Posterior respiratory or breathing organ, appendage, tube or process: An appendage borne terminally or dorsally on the twelfth (last) larval segment, consisting of two tubes more or less completely fused mesad throughout their length, enclosing two large tracheæ and bearing on their ends the posterior larval spiracles (q. v.) through which the tracheæ open. This tube is considered for descriptive purposes to have been originally a terminal appendage; consequently its *length* is the distance from its base (where the tube becomes differentiated from the last segment) to its apex; its *width* is the maximum transverse diameter across both stigmal plates (q. v.); and its *depth* or *height* is the maximum dorso-ventral distance at the tip when oriented as described above; (when the tube is very short and directed dorsad, what appears to be the cephalo-caudad distance).

Pupal respiratory cornua: A pair of chitinous terminations of the tracheæ leading to the prothorax of the developing fly, which are pushed through the puparium, dorso-cephalad, for respiration during the pupa stage. Their surface bears a few or many denticles or papillæ about which the air enters. Sometimes very conspicuous, sometimes (especially on the puparia of aphidophagous larvæ) exceedingly minute and indistinguishable (Fig. 30-*7A*).

Segmental bristles, hairs, spines or vestiture: A transverse row of more or less prominent hairs or other armature, specialized from the integumental vestiture (q. v.) across the dorsum and sides of each larval segment. These hairs are twelve in number, and for convenience in description, I have named them in order, beginning with the pair nearest the mid-dorsal line and proceeding laterad and ventrad: a, *median;* b, *dorsal;* c, *dorso-lateral;* d, *lateral;* e, *posterior ventro-lateral;* and f, *anterior ventro-lateral.*

Segmental elevation or cone: A more or less prominent conical fleshy elevation subtending a segmental bristle (q. v.).

Slit-like spiracle: One of the three pairs of openings of the tracheæ at the posterior end of the body of the larva, on the stigmal plate (q. v.); usually straight or slightly curved but often sinuate, convoluted or undulated, and may bear lateral projections or denticles. They usually radiate and are usually elevated on carinæ. They are named dorsal, median and ventral pairs the former usually nearest the circular plate.

Spiracle: An opening to a trachea, or breathing pore. See anterior larval spiracle, slit-like spiracle, stigmata.

Stigmal plate: Either half of the truncated apex of the posterior respiratory process, usually separated from the other lateral half by a distinct median dorso-ventral incision. It bears three slit-like spiracles (q. v.), the circular plate, and the interspiracular ornamentation.

Stigmata: See spiracle, pupal respiratory cornua.

Ventral line: The margin of the puparium, when viewed from the side, extending from the position of the larval mouth-parts in front, along the venter to the base of the posterior respiratory process at the posterior end.

Ventro-lateral carina: An irregular, longitudinal, fleshy ridge along the side of the body of the larva underneath the dorso-lateral carina and bearing the lateral segmental bristles.

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FIGURES AND EXPLANATIONS

EXPLANATION OF FIGURE 29.

Pipiza pisticoides Willist.

1 Side view of larva x12; A, lateral mouth-hook, immediately in front of which is the antenna; B, anterior larval spiracle; C, posterior respiratory process.

2 End view of posterior respiratory process x185; showing the two stigmal plates, each with a circular plate, interspiracular hairs and slit-like spiracles.

3 Side view of puparium x12.

4 Dorsal view of adult female x18.

Didea fasciata Macq. var. *fuscipes* Loew.

5 Sculpturing on egg-shell of *Didea fasciata fuscipes* (q. v.)

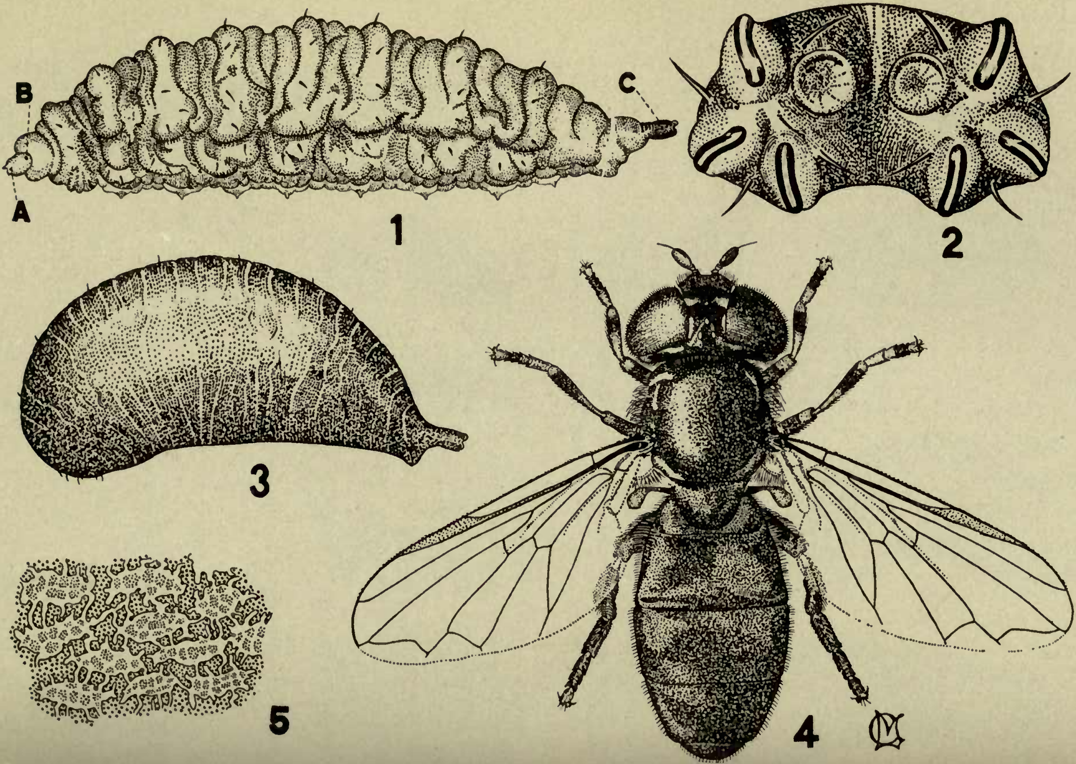


Fig. 29. Life-stages of *Pipiza pisticoides* Willist.

EXPLANATION OF FIGURE 30.

Melanostoma mellinum Linné.

1 Masses of eggs as deposited by female on leaf of rape x12.

2 Egg-mass from another female, showing the characteristic ranking of eggs side by side, x12.

3 A small area of the egg-shell highly magnified, showing nature of sculpturing.

4 Ventral view of head-segments of larva much enlarged; A, lateral mouth-hook; B, antenna; C, upper jaw; D, anterior larval spiracle.

5 End view of posterior respiratory organ x 175, showing the two stigmal plates; A, the carina bearing left, dorsal, slit-like spiracle; B, right circular plate; C, one of the inter-spiracular nodules.

6 Dorsal view of larva x 10; A, left longitudinal tracheal trunk; B, antenna; C, termination of the right tracheal trunk in the anterior spiracle; D, posterior respiratory organ.

7 Dorsal view of puparium x 10; A, right pupal respiratory cornua with trachea leading from it; B, posterior larval respiratory organ. The outline of head, thorax with wing-pads, and abdomen of the developing fly shcw thru the puparium.

8 Side view of pupal respiratory cornua, highly magnified.

9 End view of pupal respiratory cornua with afferent trachea, highly magnified.

10 Side view of head of adult ♀.

11 Wing.

12 Abdomen of ♀.

13 Posterior part of thorax and abdomen of ♂.

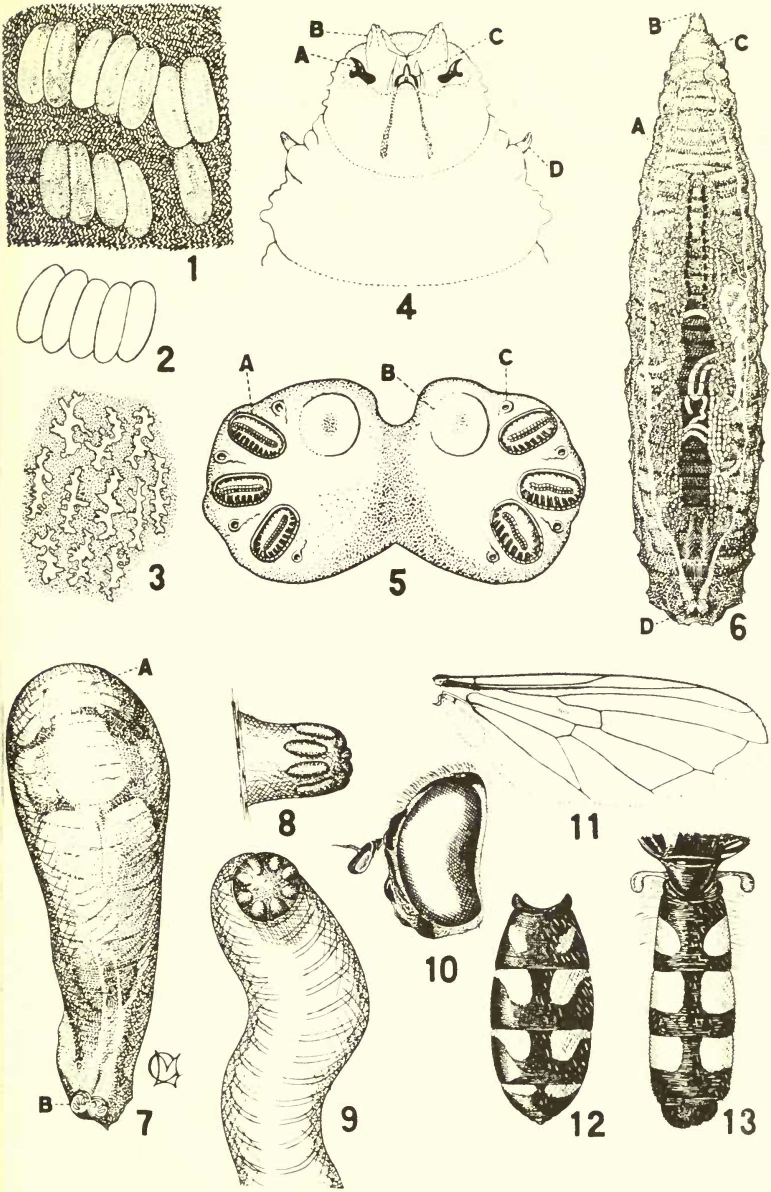


Fig. 30. Life stages of *Melanostoma mellinum* Linné.

EXPLANATION OF FIGURE 32.

Syrphus americanus Wied.

41 Egg from the side x 17.

42 Dorsal view of egg x 17.

43 A small part of the surface of egg-shell showing sculpturing, highly magnified.

44 Adult male about 5 times natural size.

45 Larva just hatched x 59; a, posterior respiratory appendage.

46 Full-grown larva x 7; a, antennæ; b, anterior spiracle; c, posterior respiratory appendage.

47 Anterior view of larva, much enlarged, showing mouth-parts, antennæ, etc.; a, right anterior spiracle; b, antenna; c, upper jaw; d, lower jaw; e, the three pairs of mouth-hooks.

48 Dorsal view of right anterior spiracle, highly magnified.

49 End or posterior view of posterior respiratory organ x 55; a, dorsal spiracular spine; b, one of the three pairs of slit-like spiracles.

50 Side or dorsal view of posterior respiratory organ x 55; lettering as in Fig. 49.

51 Appearance of a part of the puparium externally in the region of the mouth-parts much enlarged; a, right anterior spiracle with short piece of trachea attached; b, lower jaw of larva; c, upper jaw of larva; d, chitinous esophageal framework; e, mouth-hooks of larva.

52 Hind leg of pupa showing flexure of tibiæ at a.

53 An early pupal stage from the side; a, b, and c, developing legs; d, wing-pad; e, mouth-parts.

54 A much later pupal stage, ventral view; a, the delicate investing membrane.

55 Dorsal view of puparium x 5; a, posterior respiratory organ.

56 Outline of puparium from the side. The dotted outline is given to show the typical shape of a parasitized puparium.

57 Lateral view of head of female x 7.

58 Larva of parasite, *Bassus laetatorius;* mouth-parts at a, ventral view.

59 Pupa of *B. laetatorius,* ventral view.

Figs. 53, 54, 58, and 59 each about 5 times natural size.

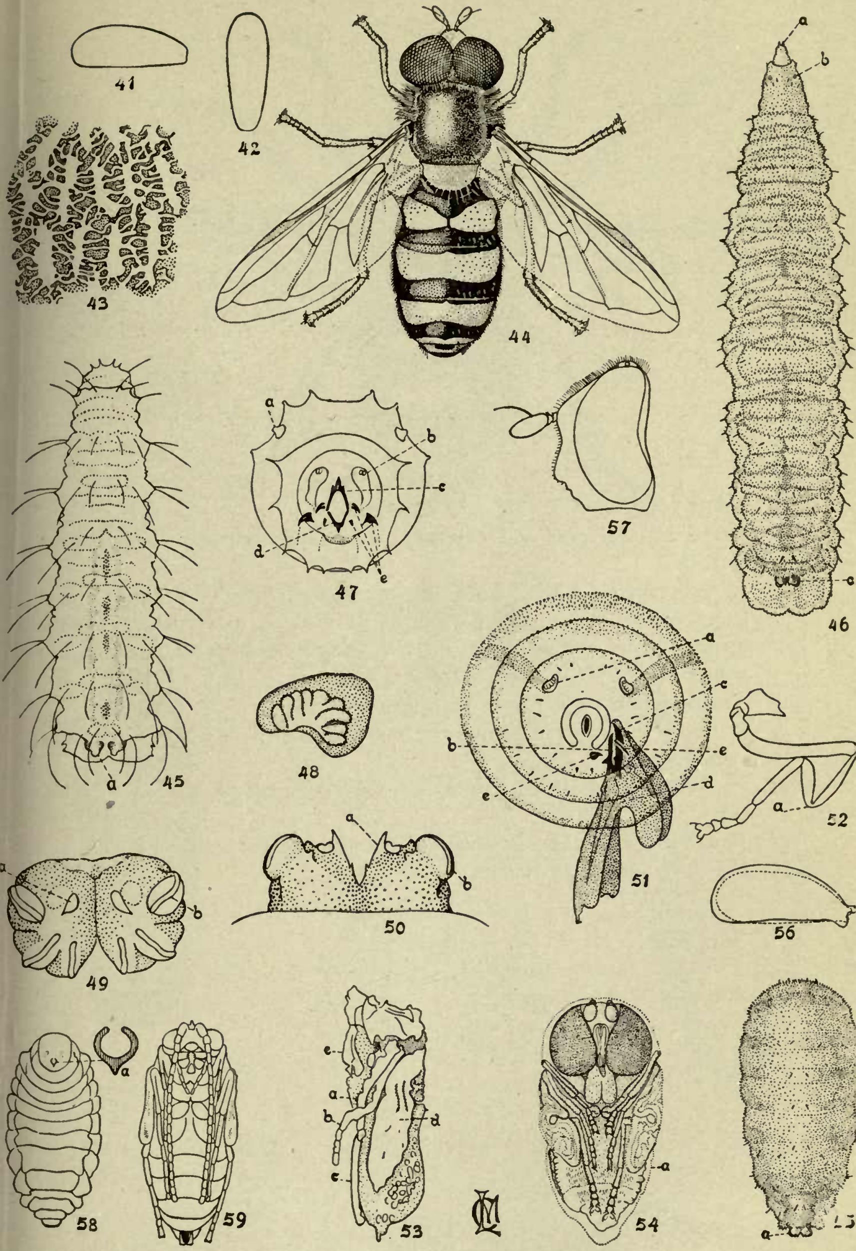


Fig. 32. Life stages of *Syrphus americanus* Wied. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 33.

Syrphus torvus Loew.

9 Adult male, natural size and enlarged.

10 Larva, natural size and enlarged; a, anterior spiracle; b, posterior spiracle.

11 Antero-ventral view of head and mouth-parts much enlarged; a and b, upper and lower jaws partially separated; c, outer pair of mouth hooks; d and e, two inner pairs of mouth-hooklets; f, antenna; g, anterior spiracle; h, sense papillæ.

12 Anterior spiracle of larva highly magnified.

13 Posterior breathing appendages much enlarged; a, one of the six caudal spiracles.

14 Puparium from above, natural size and enlarged; a, posterior spiracles.

15 Puparium from side showing line of cleavage for escape of adult.

16 Head of female in profile.

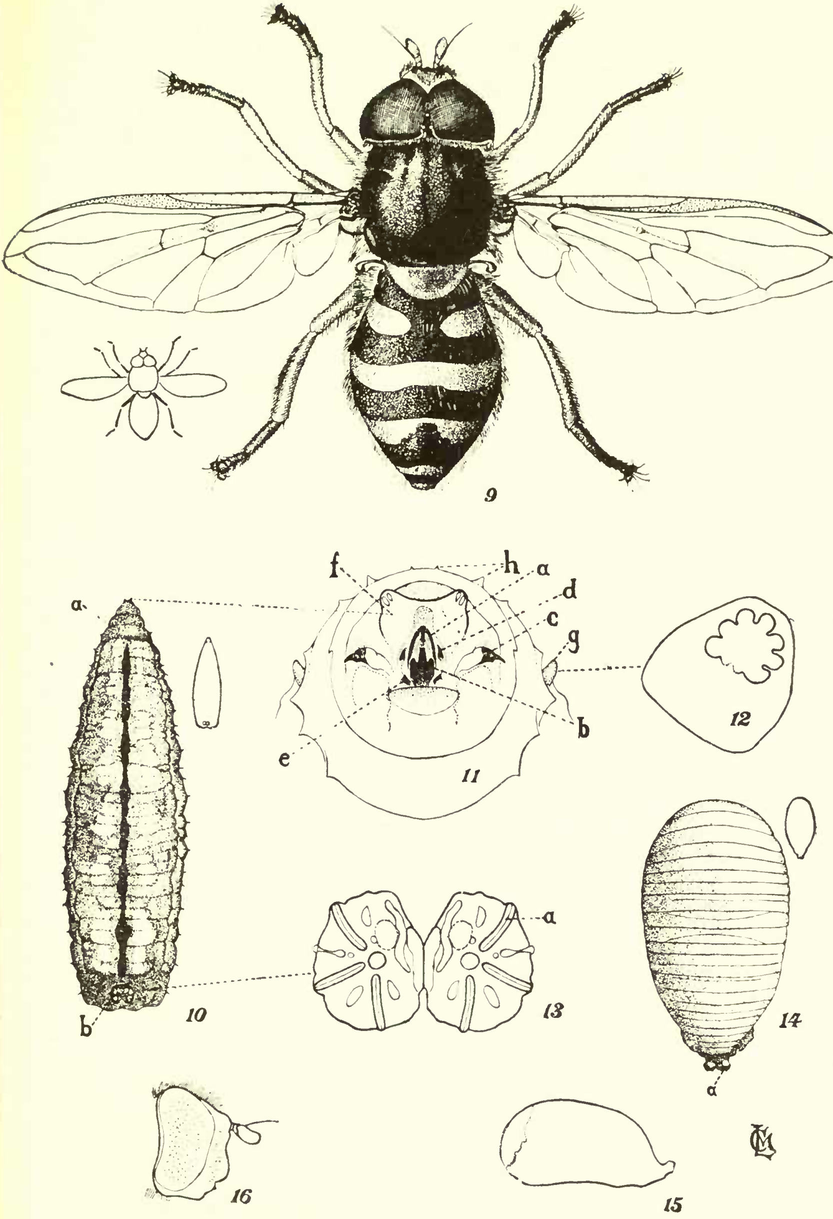


Fig. 33. Life-stages of *Syrphus torvus* Loew. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 34.

Syrphus nitens Ztt.

1 Dorsal view of larva x 7.5; A, antenna; B, posterior respiratory organ.

2 Anterior larval spiracle, highly magnified.

3 End view of posterior respiratory organ x 75, showing the two stigmal plates; A, circular plate; B, one of the inter-spiracular nodules; C, median slit-like spiracle.

4 Postero-ventral view of posterior respiratory organ x 75, showing the position of the three pairs of extensively-convoluted, slit-like spiracles; the carinæ on which they are elevated; and the ridges median to the circular plates.

5 The retractile, renal? flabellæ, as protracted from the anal opening.

6 Dorsal view of puparium x 7.5; showing shape, markings, and at A, the posterior, larval, respiratory organ.

7 Dorsal view of adult ♂, x 7.5.

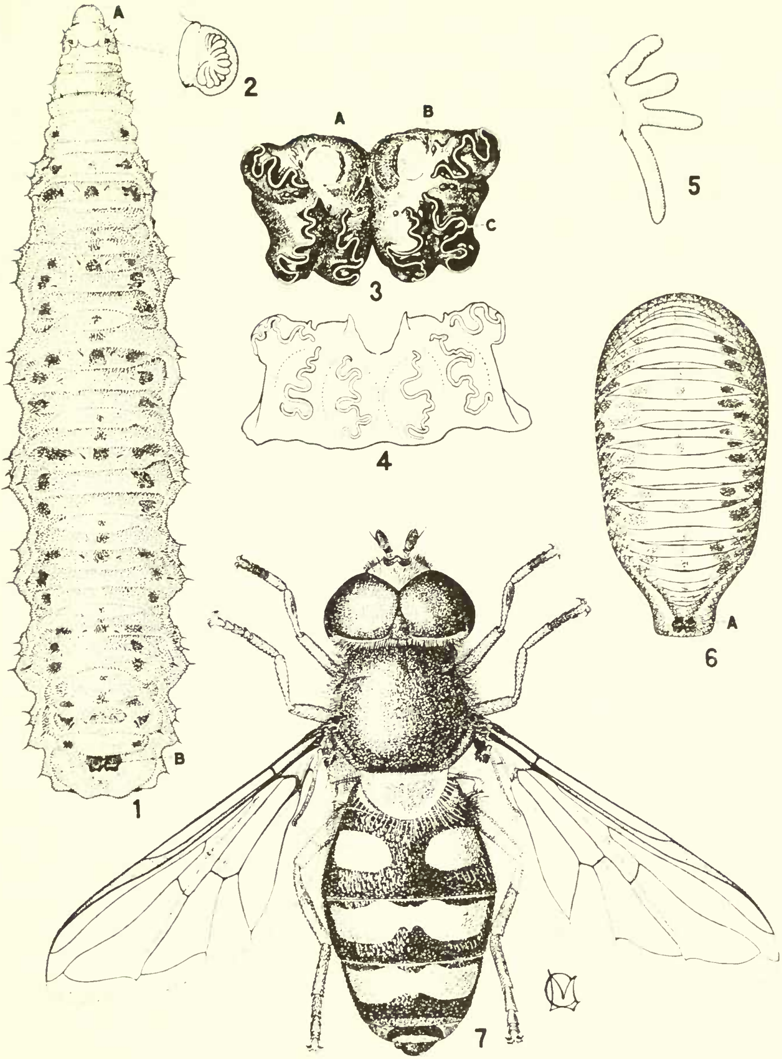


Fig. 34. Life-stages of *Syrphus nitens* Ztt.

EXPLANATION OF FIGURE 35.

Didea fasciata Macq. var *fuscipes* Loew.

1 Adult female x 6.

2 Larva about six times natural size; a, anterior spiracle; b, caudal spiracles.

3 Antero-ventral view of head and mouth-parts of larva, enlarged; a, upper jaw with a small pair of hooklets at the side; b, lower jaw; c and d, lateral hooklets; e, antenna; f, sense papillæ.

4 Right anterior spiracle much magnified.

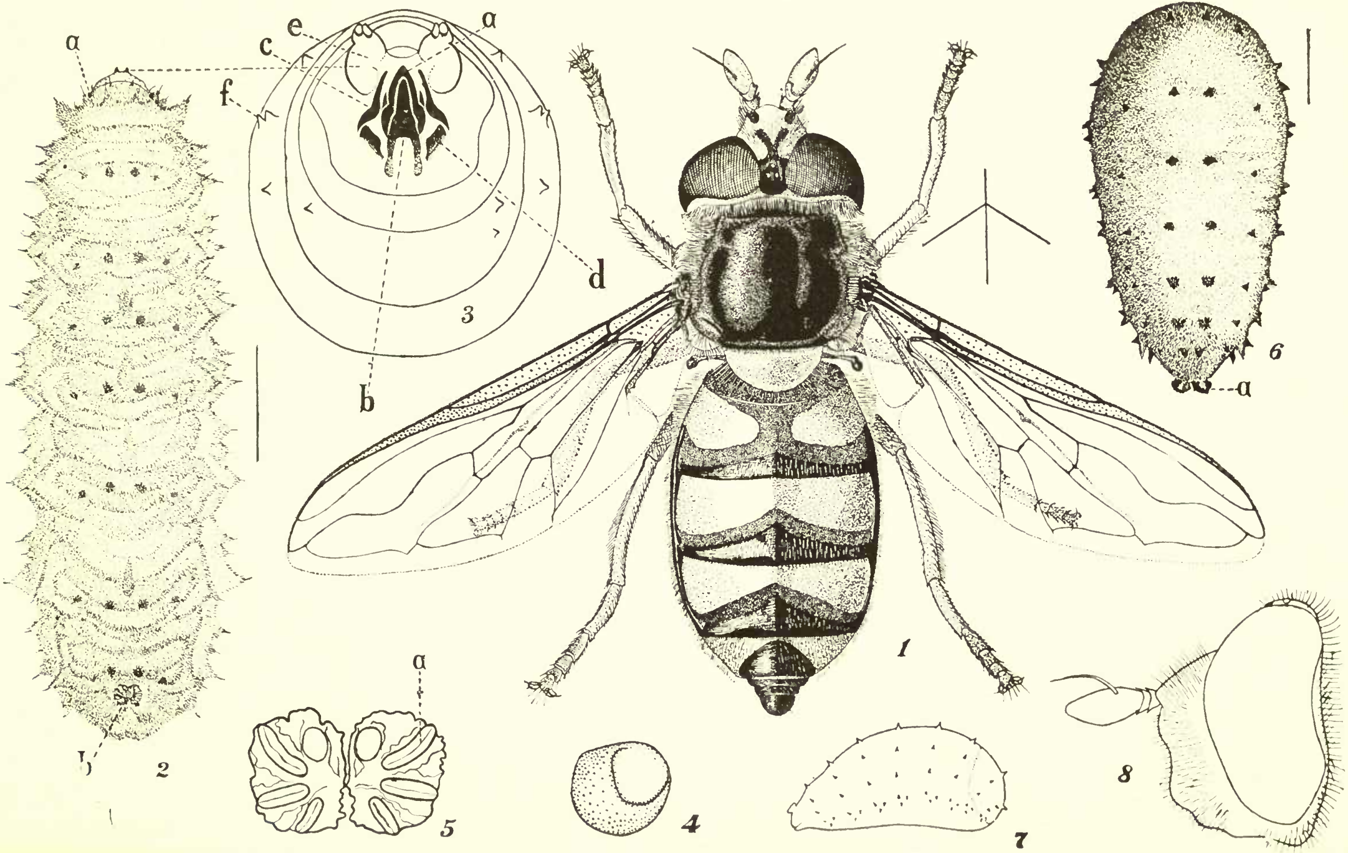
5 Posterior breathing organs enlarged; a, one of the radiating spiracles.

6 Dorsal view of puparium a little more than five times natural size; a, caudal spiracles.

7 Puparium from the side showing arrangement of spines and line of cleavage for escape of adult.

8 Head of male in profile.

See also Figure 29-5.


a
b
2
e
c
f
a
d
b
3
1
a
5
4
7
a
6
8

EXPLANATION OF FIGURE 36.

Tropidia quadrata Say.

1 A few areoles from one of the bodies on the surface of the egg-shell, very highly magnified.

2 A small area of the chorion or egg-shell, highly magnified, showing the elevated bodies each of which is further ornamented with a number of rounded areoles.

3 Dorsal view of an egg x 22.

4 Anterior larval spiracle highly magnified.

5 Dorsal view of larva x 6; A, antenna; B, anterior larval spiracle, just laterad of which are the two large lateral hooks; C, posterior respiratory organ, at each side of which are the three lateral fleshy processes from the body-wall.

6 End-view of posterior respiratory organ, showing the two stigmal plates; A, one of the palmately-arranged groups of plumose, inter-spiracular hairs; B, circular plate; C, dorsal slit-like spiracle showing characteristic shape and dentations; much magnified.

7 Anterior view of head-segments of larva, much enlarged, showing arrangement of spines or thorns; A, the posterior row of thorns; B, anterior larval spiracle, situated in the middle row of thorns; C, the two pairs of large, lateral thorns, between which is the anterior row of thorns; D, left antenna; E, the first pair of pro-legs; F, the mouth-hood.

8 Lateral view of puparium x 6; A, left pupal respiratory cornua; B, posterior larval respiratory organ, at the side of which are the three lateral processes from the body-wall. Note also in the cephalo-ventral region the thorns of the larval head.

9 A group of papillæ from the pupal respiratory cornua, very highly magnified, each showing a number of nodules arranged in a circle.

10 Anterior view of puparium x 12; A, left pupal respiratory cornua; B, anterior larval spiracle; C, remnant of the larval mouth-hood; D, the two large lateral thorns or hooks of the larval head. The heavy dotted lines enclose the two pieces of the operculum which split off for the emergence of the adult.

11 Side view of head of male, showing characteristic facial carina.

12 Dorsal view of scutellum and abdomen of male, showing characteristic markings.

13 Wing.

14 Hind leg showing angular projection at outer end of femur.

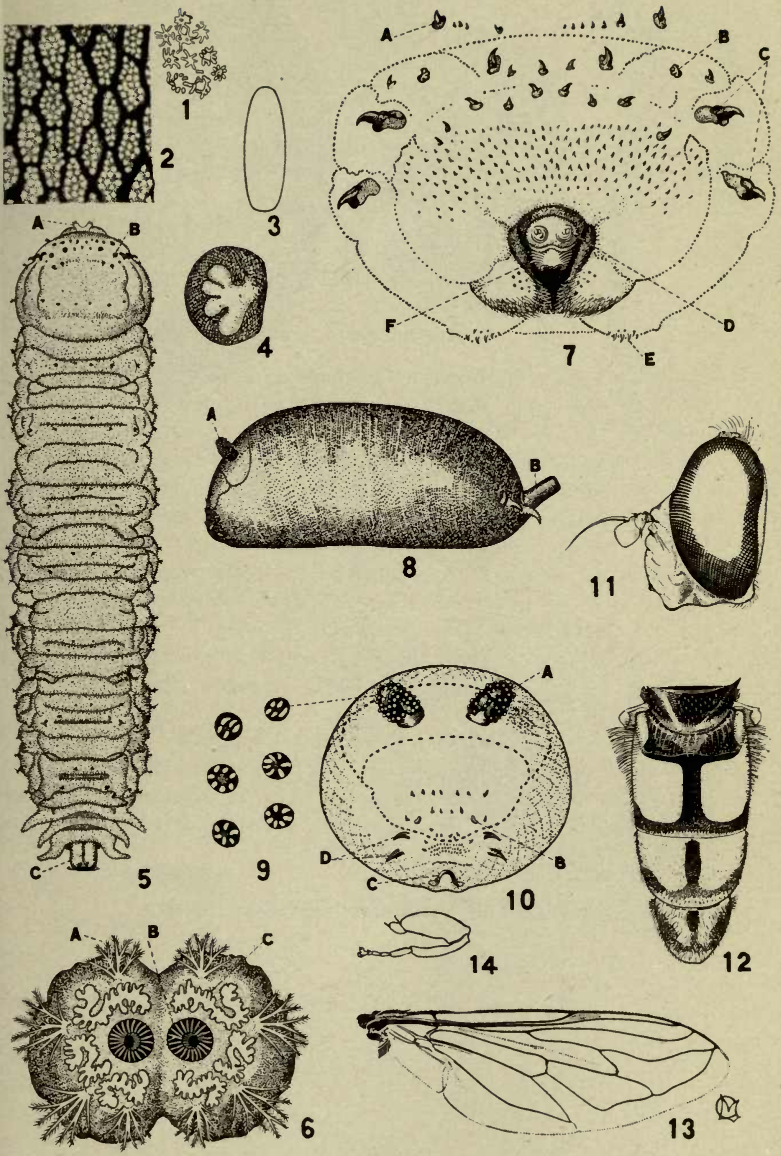


Fig. 36. Life-stages of *Tropidia quadrata* Say.

EXPLANATION OF FIGURE 37.

Syritta pipiens Linné.

1 A mass of eggs as deposited by a female on filth x 20.
2 A few areoles from one of the bodies on the surface of the egg-shell, very highly magnified.
3 A small area of the chorion or egg-shell highly magnified, showing the elevated bodies each of which is further indistinctly marked with rounded areoles.
4 Anterior larval spiracle, highly magnified.
5 Larva, dorsal view x 6; A, antenna; B, posterior respiratory organ.
6 Dorsal view of puparium x 6; A, pupal respiratory cornua; B, posterior larval respiratory organ.
7 A group of papillæ from the pupal respiratory cornua each composed of four to six nodules circularly arranged; very highly magnified.
8 One of the pupal respiratory cornua much enlarged.
9 End view of posterior respiratory organ, showing the two stigmal plates each with a circular plate, three slit-like, sinuate and denticulated spiracles (A), and four groups of palmately-arranged, plumose, inter-spiracular hairs.
10 Wing.
11 Hind leg, showing color-pattern and spines on femur.

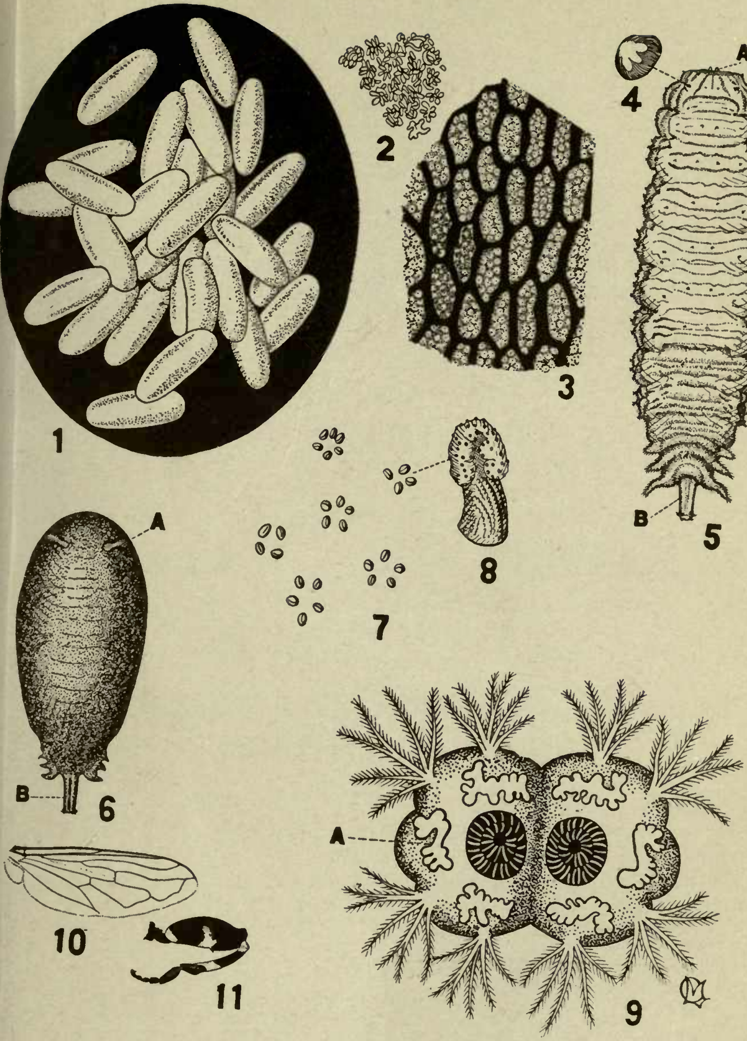


Fig. 37. Life-stages of *Syritta pipiens* Linné.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN 254 SEPTEMBER, 1916

STUDIES OF LIFE HISTORIES OF FROG-HOPPERS OF MAINE

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†In collaboration with U. S. Department of Agriculture.

BULLETIN 254

STUDIES OF LIFE HISTORIES OF FROGHOPPERS OF MAINE.*

HERBERT OSBORN.†

MEADOW FROGHOPPERS.

The species of froghoppers common in meadows belong to two species, *Philaenus lineatus* and *P. spumarius,* which will be discussed in detail separately. Certain features are common to the two species but in certain respects they are very different. Both produce large quantities of frothy matter "spittle," and this is formed by liberating air beneath the fluid discharged from the anal opening. See figs. 48 and 49. This fluid evidently contains sufficient albuminous or gelatinous material to form a slightly viscid mixture so that the air liberated within it forms little bubbles that persist for a long time, some remnant of the frothy mass adhering to the plants for some time after the insects have emerged as adults and taken their departure. I am not aware of any study of the composition of the froth and it seems to have been assumed that the frothy condition was due to air in the fluid just as it is discharged from the alimentary canal. I have noticed however that there is a distinct secretion from the sides of the seventh and eighth abdominal segments, apparently a glairy or viscid substance, quite evident when the living insect is submerged in weak alcohol It seems to be slightly coagulated but not dissolved in the alcohol and it appears probable that the addition of this substance to the discharge from the alimentary canal furnishes the viscid quality to the mass that is necessary to maintain its frothy con-

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*Papers from the Maine Agricultural Experiment Station; Entomology 89.

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dition. This condition persists even during rather heavy rains, showing a certain insolubility in water as well as in alcohol. The glands from which the secretion comes are located laterally in the abdominal segments (the 7th and 8th) and in a specimen of one of the intermediate instars, probably the third, they appear as black spots. In other instars, so far as observed, they are not specially colored but show in mounted specimens as a more opaque area while the surface is roughened over a triangular area though no gland openings have been observed in the material studied. The pores may be too minute for ready observation. A similar secretion has been observed for *Clastoptera*.

The purpose of the frothy masses is generally assumed to be for the protection of the nymph and it is easy to see that they are pretty well guarded against many of the smaller kinds of enemies such as spiders and other arthropods. Some distinct adaptations associated with the habit are to be noted as for instance, the loss in large degree by the nymphs of the leaping habit and also the nearly complete loss of color.

That these two species have a distinct preference, if not a positive restriction to particular food plants is indicated by the fact that *spumarius* is taken almost entirely from plants other than grasses while *lineatus* is taken almost exclusively from grasses, especially timothy and redtop.

As a test of their choice in this matter on July 9th ten individuals of *lineatus* were transferred from timothy to clover and of these none lived, though two had succeeded in changing to adult stage probably being very near maturity. In the reverse test ten specimens of *spumarius* were transferred from clover to timothy and only two lived to become adults, none made froth on the timothy and all showed restlessness and attempts to move. They evidently failed to secure sap and it is possible that there is some distinct difference in the mouth parts correlated with the different food plants as well as a difference in selection.

The economic importance of these species has been variously estimated though I think too generally overlooked. I find in an early record in the *Maine Farmer* for July 26, 1866, the following note by G. E. Brackett under the head of "Practical Entomology:"

"About 'Hoppers.' There is a class of insects including three families, the leafhopper, treehopper and froghopper, which present some peculiar characteristics, the species most common here is the froghopper (Cercopida) so called. Every farmer will have noticed upon plants, particularly on grass, a mass of foam or spittle-like substance, adhering to the stalk, and containing an insect, which, from the fact that it leaps when disturbed, may have been called a young grasshopper. This is the froghopper, of the order Homoptera, and entirely distinct from the grasshopper, in having a tube to suck juices instead of jaws to bite leaves, as do grasshoppers and all other orthopterous insects. These froghoppers hatch from eggs laid in the previous autumn, and immediately puncture the tender bark of the plant with their beak and suck out the sap. They take in such large quantities that it oozes out of their bodies in the form of minute bubbles which soon form a covering of foam or spittle-like substance, which gives it its name. This substance shelters it from the sun and also from insect enemies. When they become full grown in autumn they are not thus protected, but are found moving about on the plants where they lay their eggs. A description of this insect will be unnecessary, as every reader has seen them. There is general resemblance among the different families of hoppers. They are not considered particularly destructive to the plants on which they are found."

In speaking of the injuries of the spittle insects Dr. Lintner (Fifth Report on the Injurious and Other Insects of the State of New York, p. 246, 1889) remarks as follows:

"Report has been made in Vermont of one or more of the grass infesting species causing considerable damage to the hay crop. It was estimated that in consequence of the depredations, the quantity of hay grown on some fields was one-third less than the natural yield, not including the depreciation in the quality of the crop. It is but seldom however, that these insects increase to such an unusual extent as to become of serious injury, and it is therefore unnecessary to indicate any means for their destruction. A gentleman, who asks for information regarding them, states that, in passing through his mowing fields, in Auburn, Mass., they are so numerous as to wet his shoes. An abundance such as this would of course, be harmful to the crop but, fortunately it is of rare occurrence."

Occurrences such as these are perhaps less rare than is generally supposed since these insects are easily overlooked and the tendency has been to give little heed to the attacks of insects unless they are severe enough to cause a very complete destruction of a crop. I am informed by Dr. Patch that occurrences where the insects are abundant enough to wet ones shoes in walking through grass are not infrequent and in my collecting the present season I have found them plentiful enough for this purpose and often plentiful enough so that my net would become wet while sweeping the grass for specimens. As shown elsewhere by actual counts and estimates the drain on certain fields is such that it well deserves attention and the determination of measures for control.

If old fields showed uniformly small plants there would be some reason to attribute the reduction in growth to the soil or to "running out" but when scattered stems stand at good height and produce excellent heads it seems that this explanation is insufficient.

It is a peculiar sight in some fields to note a considerable number of tall well developed stalks with large heads in full bloom and along with them in exactly the same soil and exposure to sun, rain and other conditions, numerous dwarfed plants with short, blasted heads or no heads at all.

While some mention of the species has been made by these earlier writers there has been scarcely any reference to the species or their possible economic importance by later writers and there is evidently opportunity for some careful observations and experiment to determine their habits and possible measures for control. The observations recorded here it is hoped will furnish a basis for any more detailed studies that may be possible in the future, but they will serve, it is believed an immediate purpose in suggesting some measures which should help in the reduction of the losses from this source.

MEADOW FROGHOPPER.

(*Philaenus spumarius* L.)

This extremely abundant species is widely distributed in the eastern United States as well as in Europe. It is probably the species most commonly referred to in mention of froghoppers although the nearly related species *P. lineatus* has been doubtless often the basis of comment. In general works the two species are seldom distinguished but since they have a different food plant range and other differences in habit, a more exact reference seems desirable. In common usage froghopper covers both these and certain other species. To make a more precise distinction I would propose this species be called the

Meadow Froghopper and the *Philaenus lineatus* Grass-feeding Froghopper.

The distribution of the species covers the northern United States west to the plains region at least and in Maine its occurrence may be expected throughout the entire state. In fact it is one of the most abundant species encountered in meadows and pastures and it is found occasionally in cultivated fields of oats.

There is a quite wide range of food plants including many of the compositae as well as several cultivated crops. Among the food plants specially noted were buttercup, yarrow, thistle, helianthus, orange dock, daisy, clover, primrose, chokecherry and plum.

Its economic importance is of course considerably affected by the fact that many of its foodplants are noxious weeds and if it would confine its attacks to such plants it might be counted very useful but since it feeds abundantly on clover its presence in meadows must be counted detrimental.

In life history the species agrees very closely with *P. lineatus* so much so that one statement will almost answer for the two.

NATURE OF THE INJURY.

The effects of the attacks of this species are most apparent on the blossoms or the seed formation and in many cases are very evident. This is especially evident in the case of the buttercup which seems to be one of the favorite foodplants. Buttercup heads were marked to indicate those blossoms that were on stems attacked by the hoppers and four marked heads on a plant that bore eight other heads. The four attacked all withered and failed to produce seed while six of the others formed good seed heads and the other two were still in blossom at time the observation closed. See figs. 44 and 45.

Clover blossoms also show the same effect and there is no doubt that the hoppers must be a distinct factor in the reduction of the formation of the perfect clover heads.

Where buttercup is present *spumarius* seems to gather on it in preference to other plants though clover is apparently nearly as much affected.

LIFE HISTORY.

As already indicated the eggs of this species are believed to pass the winter in the meadows where the nymphs are observed in summer and probably they are found in the stems of their various food plants or possibly in dead stems or leaves at the surface of the ground.

The larvæ hatch in early summer, the earliest record which we have for the season of 1916, being June 13. The nymphs were mostly well along at the time of my first field observations in June and I conclude that the rate of growth is rather rapid for the latter part of June as during this time and early July but few less mature than the final instar were to be found. On July 10th these last instar individuals were still plenty on buttercup and a recently emerged adult was observed on dandelion. From the middle of July only adults were observed but these were evidently still feeding and it is certain that mating and egg development are carried along slowly. Mating was observed July 28th, and at this time adults of both sexes were abundant in clover in a meadow. One mated individual, dissected showed no evidence of egg development beyond the most immature formation and no indication of shell. By the middle of August egg development has proceeded so that occasional eggs are found with well formed shells but usually only a few mature eggs along with many imperfect and undeveloped ova in the oviducts. Figure 46 shows this condition as noted in a specimen dissected in August. The large black bodies are the eggs with shells and the faint ones those still unformed. The large spermatheca may also be observed above the ovipositor. No spermatozoa could be detected in the spermatheca but from its size it would seem quite certain that they must be retained for some time and the eggs are fertilized as they mature through a long period possibly several weeks during late summer and early autumn.

No egg deposition was observed before my leaving Maine the last of August and the only eggs seen were those dissected from the females during August.

Description of Early Stages.

Egg: The egg is moderately elongate, irregularly elliptic, about three times as long as broad, narrowing to one end, slightly flattened, one side straight or slightly incurved the other convexly curved, giving the egg a slightly curved appearance. The shell is tough and hard and developed while the eggs are still in the ovariole ducts.

The first instar observed is from two to three millimeters long, the head before the eyes strongly inflated semiglobose or bulbous, polished, with faint arcs on the front. Antennæ short, 8- or 9-jointed, first joint short, 2nd large, 3rd cylindric, 4th to 9th tapering, eyes dark, a distinct transverse furrow or suture across vertex between bases of antennæ. Beak reaching to third pair of legs.

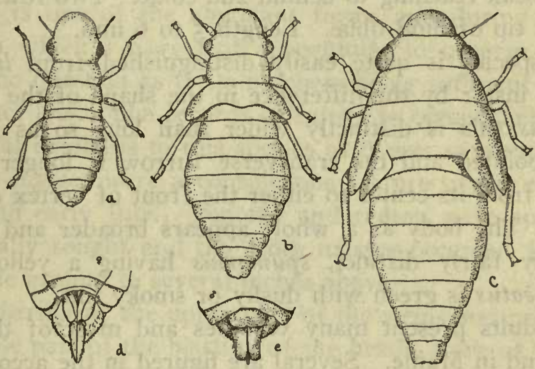


Fig. 38. *Philaenus spumarius, a,* young nymph; *b,* intermediate; *c,* last instar, all enlarged; *d,* female; *e,* male, genitalia. (Original.)

The second instar observed (possibly the 3rd in full series) has the head cordate, front bulbous, a depressed suture from antennal bases, forming a distinct transverse furrow, antennæ 9-jointed; 1st short, 2nd large, short cylindrical, 3rd longest cylindrical, 4th to 9th tapering gradually to tip. Eyes dark brown, reddish on the margins. Prothorax cylindrical; mesothorax expanded at sides to form beginning of wing pads, wider than metathorax slightly produced posteriorly, tips reaching nearly to hind border of the metathorax, hind border slightly curved, metathorax slightly expanded at sides, hind border nearly straight, transverse; legs not distinctly spined, a few weak points at tip of hind tibiæ. Abdomen widening to 3rd segment, tapering to tip, valves distinct. Length, 4 mm.

In the final instar observed the head is distinctly more pointed though the front is decidedly bulbous, ocelli are evident, the wing pads have developed backward so as to include the first two abdominal segments, those of the mesothorax being appressed to those of the metathorax and reaching almost if not quite to their tips. Head with vertex produced, subangulate, a depressed furrow crossing between the bases of the antennæ, ocelli slightly nearer the hind border and about equally distant from each other and from the eye. Antennæ 9-jointed, those following the third becoming more slender and setaceous. Eyes narrower, the larger part visible from below, red-brown appearing transversely barred, front tumid, clypeus strongly convex, beak reaching to behind 2nd coxæ. Two rows of black spines at tip of hind tibiæ. Length 5 to 6 mm.

This species is quite easily distinguished from *lineatus* in the final instar by the difference in the shape of the head. In *spumarius* this is distinctly wider than long so as to appear bluntly pointed and the transverse furrow is longer than the distance from its center to either the front of vertex or to rear margin. The body as a whole appears broader and the color is usually fairly distinct, *spumarius* having a yellowish tint while *lineatus* is green with dusky or smoky tint.

The adults present many varieties and most of these have been found in Maine. Several are figured in the accompanying plate (fig. 47) which shows also at bottom one of the nymphs.

There is apparently no relation in these varieties to the food plants as different varieties have been found to mature from nymphs feeding on the same plant. Furthermore individuals of different color varieties are found mating together, apparently without any reference to color pattern.

The typical form of the adult is easily seen from the figures, the head bluntly angular, the body elongate oval, widest about the middle, the elytra extending well beyond the end of the abdomen and the length from five to six millimeters. The color varies from pale gray to black and the markings in the form of irregular spots, broken cross bands, or longitudinal stripes.

Grass-feeding Froghopper.

(*Philaenus lineatus L.*)

This species appears to be a distinctly grass-feeding species and as noted in the preceding section seems unable to maintain itself on plants outside the grass family.

The species has a wide range in the northern hemisphere occurring over a wide territory in Europe and North America, but in the United States appears to be distributed especially through the northern portion, occurring from Maine to the Rocky Mountains. It seems to occur in greatest abundance in the New England States and, in meadows which are kept in grass for a number of years in succession, it undoubtedly must be ranked as a distinct pest. While seldom if ever alone in its attacks, being associated with various jassids and other sucking insects, it is one of the abundant forms and during the two seasons in which I have had opportunity to observe it there has been no question as to its numbers being sufficient to occasion distinct loss. The records of injury to certain fields apply with special emphasis to this species as it was so plentiful that the frothy masses were a conspicuous feature of the meadows in June and early July. Timothy and redtop were apparently about equally sought and the froth masses occurred from the level of the ground to several inches above.

The withering of the upper part of the stems and probably a considerable part of the blasting of the heads, some of which is doubtless due to thrips (*A. striatus* Osb.) or to Jassids may be attributed to this attack.

At the time of my arrival in Orono, the last of June, the nymphs had largely reached the final stage of growth so that I do not have observations on the earliest appearance. Judging by their maturity however and also by the stages of growth shown in the related *P. spumarius* it is probable that the eggs hatch and larval life begins in late May or early June.

On June 27th, 1914, at my first opportunity for personal observation the species was found plentifully on timothy and redtop, all found being in the nymphal stages and included in the froth masses, sometimes as many as two or three of the froth masses and included larvæ on a single grass stem. The most mature at this time was one with the wing pads developed evidently in the final nymphal instar. The final instar occupies a period of two or three weeks and corresponds closely with the time of rapid growth and formation of heads in the grass, the nymphal stage being passed and adults beginning to appear at about the time of hay cutting July 3rd to 10th.

The mature nymphs are easily distinguished from those of *spumarius* by the more slender body, the narrower front portion or inflated part of the head and by a more dusky coloration, especially as they approach moulting.

The process of emergence is interesting and apparently varies slightly in different individuals, but in cases observed the emergence occurred within the froth masses. The nymphal case is included within the remnant of the froth mass that remains attached and clings to the grass stem for some time. The head is closely appressed to the stem and directed toward the upper part of the stem, the abdomen is elevated and this and the thorax are both split along the dorsal line. The front legs clasp the stem, but the middle and hind legs are free.

The remnant of froth mass retains closely the original form and shows the form of individual bubbles, a condition which certainly points to the presence of some content that gives a gelatinous consistency to an otherwise watery mass.

The full life cycle of this species has not been followed and there are several points in the cycle which it will be especially interesting to determine. Nevertheless, enough is known concerning certain of the most critical periods of development to furnish a basis for the application of certain measures of control.

That the winter is passed in the egg stage as has been generally stated and is evidenced by the occurrence of larvæ in our cages, placed in early spring over timothy grass in meadows. Adults certainly could not have entered there to deposit eggs in spring and if adults had hibernated in the grass we should have found some at least of the dead bodies present within our cages.

The date of egg hatching cannot be given precisely, but the earliest appearance of the froth masses in June would indicate a rather late hatching, at least for this latitude.

During June only young are to be found and during this period they pass through three or four moults. Three instars at least are represented in material collected June 19th, 26th and 27th.

In rearings from nymphs collected on grass the latter part of June adults were secured during the first week in July. In one case a nymph enclosed June 29th moulted July 1st and emerged as adult on July 5th and in another case a nymph probably recently moulted caged July 9th, developed to maturity and adult emerged July 11th. These all indicate a short nymphal period and rapid growth.

The adults continue to feed and up to July 29th no signs of egg maturity or egg deposition had been noted. Egg development is evidently slow and mating and egg deposition must occur irregularly, probably extended over a period of some weeks in autumn.

Ovaries from females, collected in the field, were dissected and four well developed eggs were found with definite shell, but no evidence of segmentation. A number of apparently undeveloped eggs were in the ovarioles.

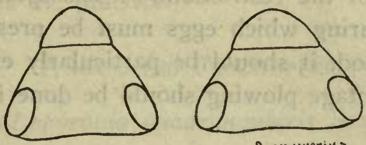


Fig. 39. Relative form of head in *Ph. lineatus* and *spumarius* nymphs of final instar.

Comparing the final instar especialy with *spumarius* the head is longer and the front more distinctly produced. In *spumarius* the part in front of the suture is in the ratio of 10 to 24 while in *lineatus* it is as 11 to 20 and the head entire in *spumarius* is in ratio of 44 wide to 31 long in *lineatus* as 40 wide to 34 long as taken in average for several specimens.

Lineatus is further distinguished by the dusky coloration especially toward the posterior end of the body as the nymph approaches maturity.

Some very small specimens of this species were taken at Saddleback Lake in the summer of 1916, the smaller ones only

4 mm. long, and many froth masses were noticed on the small dwarfed plants of Canadian bluegrass growing on rocky ledges. It seems possible that the depauperate condition of the grass and of the froghoppers living on it may be a mutual adaptation to a deficient food supply.

Adults of *lineatus* are distinguished from *spumarius* by the narrow, more parallel sided form and the longer head. The head is rounded angular in front and as wide as the thorax.

The color is gray with a whitish margin to the costa, bordered by a blackish line which fades out toward the end of the elytron. The length is from four to five millimeters.

REMEDIES OR CONTROL.

It seems very evident that the most effective control for this species lies in a frequent rotation from grass to some other crop and the general freedom from infestation in timothy meadows not older than two or three years as compared with the great abundance in old meadows, emphasizes this point.

This applies of course to many other of the grass insects, but on account of the restrictions of this species and the fact that the time during which eggs must be present is extended over a long period, it should be particularly effective. To be of greatest advantage plowing should be done in spring or late in fall.

It is recognized that there are many situations especially in wooded pastures and rougher meadow land where it is desirable to maintain a grass crop for a long succession of years and it is hoped that measures for reducing or eliminating these pests will make this possible without sacrificing such a large percentage of the crop.

Of the measures available for permanent meadows three seem worthy of mention and thorough trial.

While egg deposition has not been actually observed it is almost certain that the eggs are placed in grass stems and that they remain during fall, winter and early spring in this condition. It will be evident that burning of the surface dead grass, when this is allowable, will furnish a means of destroying the eggs of these and many other species.

Hopper dozer treatment immediately after haying to catch recently developed adults, would probably be the best time for use of this measure.

The hopper dozer method consists in the use of a strip of sheet iron, ten or fifteen feet in length, coated with coal tar or tanglefoot, and drawn over the surface of the grass land with about the rate of a rapid walk. Its success depends upon the fact that the hoppers when disturbed jump up a few inches from the grass and this means that they will usually fall back upon the sticky surface and be caught. The tar or tanglefoot must be replaced as often as it becomes so loaded with insects as to permit them to escape.

Early mowing would probably reduce the number materially and where the insects are abundant the gain in later growth would probably compensate for loss in quantity of crop. A trial of this was attempted, but circumstances delayed the first mowing till the bulk of insects were ready to become adult, so no conclusive results were secured.

That such mowing would be of service is indicated by the entire absence of these insects on lawns where early and frequent mowing is the practice.

ANGULATED FROGHOPPER.

(*Lepyronia quadrangularis* Say.)

This species is not an abundant one in Maine, and apparently has no particular economic importance, but since it resembles the common meadow froghoppers it is desirable to show its distinctive characters.

It has not been observed, except in the latter part of the season, and so far as present evidence shows, there is a much belated single brood in the latitude of Orono, the larvæ of which develop during August, the adults being present during late August and through Sept.

Nymphs were first collected Aug 14th and included three well marked stages, representing evidently different instars and probably the second, third and fifth if the full series includes five instars. Adults appeared in the fields on the 18th, and a reared specimen was secured on the 17th from the nymphs collected on the 14th.

The nymphs are included in froth masses similar to those of the other froghoppers and are smooth and highly polished light green in color, becoming slightly more yellowish in later stages, the head distinctly blunt, almost truncate in front and the front somewhat flattened as compared with the bulbous form of the species of *Philaenus*.

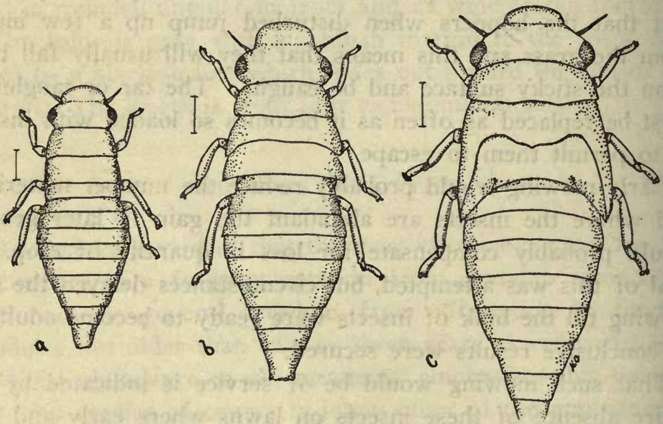


Fig. 40.

The smallest individuals taken (2nd instar?) *a*, Fig. 40, are 4 mm. long, tylus broad and distinctly truncate, beak reaching base of abdomen, the meso- and metathorax with no distinct development of wing pads, the color light green. The abdomen is pyriform, a little wider on third segment than thorax, the legs nearly uniform in size, the third pair slightly larger.

The next larger individuals (3rd instar?) *b*, Fig. 40, are 5-6 mm. long, similar in shape and color to the preceding stage, but with the wing pads clearly indicated, those of the mesothorax extending only slightly over the hinder ones, the beak reaching to the third coxæ.

The final nymphal instar (5th?) *c*, Fig. 40, is 6 to 7 mm. long, based on measurement of three individuals, light green in color with slightly more of yellowish and with the wing pads which extend to base of third abdominal segment of yellowish or whitish color. The beak extends to base of third coxæ, the legs nearly uniform in size, the hinder pair only slightly larger than the middle and the middle a trifle larger than the front pair, the head is broadly cordate, the eyes prominent, and the front similar to the preceding stage with a slight production of the anterior border.

In all stages the pleural lobes of the abdominal segment are very large and occur on all segments to last, enclosing a broad, deep channel which, as in related species, doubtless serves especially in the enclosing of air to form the froth mass.

This species is often taken in autumn in sweeping in grass lands and probably has a variety of food plants, though so far the nymphs have been found only on the *Impatiens biflora*. The adults have been taken only in autumn and while it would be unsafe to say that no spring generation occurs, the facts at hand would indicate that there is a late deposition of eggs in fall and that these eggs remain unhatched until midsummer of the following year, then producing nymphs during August, or possibly in late July, which mature very rapidly and give rise to adults by the middle of this month.

While the nymphs of this species very closely resemble those of *Philaenus* they may be at once distinguished by the blunt form of the front part of the head, appearing from above as if the head had been pushed against some object and a circular form made broadly truncate.

Adults of this species have a quite characteristic appearance with strongly sloping elytra which bear a blackish marking, the angle of which touches the costal border. The general color is gray with often a dull suffusion of purplish or brownish tint. Length 6 mm. to 7 mm.

BUSH AND TREE FROGHOPPERS.

Parallel Spittle Insect.

Aphrophora parallela Say.

Although this insect is a very abundant one and has been known to American entomologists for nearly a century, there has been very little written about it nor any careful study of its life cycle and habits.

About the only account of its habits worthy of mention is the original description by Fitch published in the Transactions of the New York State Agricultural Society for 1857.

This account is brief and while it has been reproduced in Packard's Forest Insects neither of these works is so generally available at present as to be accessible to all who might wish to see it, and it seems desirable therefore to quote it here.

"In June, a spot of white froth, resembling spittle, appearing upon the bark near the ends of the branches, hiding within it a small white wingless insect having six legs, which punctures and sucks the fluids of the bark, and grows to about a quarter of an inch in length by the last of that month, and then becomes a pupa of a similar appearance, but varied more or less with dusky or black, and with rudimentary wings resembling a vest drawn closely around the middle of the body; the latter part of July changing to its perfect form with wings fully grown, and then no longer covering itself with foam, but continuing to the end of the season, puncturing and drawing its nourishment from the bark as before. The perfect insect, a flattened oval treehopper, 0.40 in. long, with its wing covers held in form of a roof, its color brown from numberless blackish punctures upon a pale ground, a smooth whitish line along the middle of its back, and a small smooth whitish spot in the center of each wing cover, its abdomen beneath rusty brown."

This short account while giving the main points in the life cycle of the insect leaves many points to be desired and it was in hopes of supplying some of these wanting details that observations were begun upon the species in the summer of 1914.

At this time the nymphs in their frothy masses were quite plentiful on the Scotch Pines on the University Campus and it was hoped that by watching their development to verify the connection between these nymphs and the adult form. As stated by Fitch the nymphs were attached near the tips of the twigs and their presence was made very manifest, not only by the frothy masses, but by the sappy exudations running down on the branches so that there was a distinct discoloration. Usually only one nymph was observed on a twig and these were scattered over the tree. A number were enclosed in cheese cloth coverings to secure adults, but most of these were removed by some one who evidently counted them unsightly. However the rearing of some individuals and the securing of others either in process of emergence or in close proximity to the cast off skins leaves no question as to the larvæ observed being the young of this species.

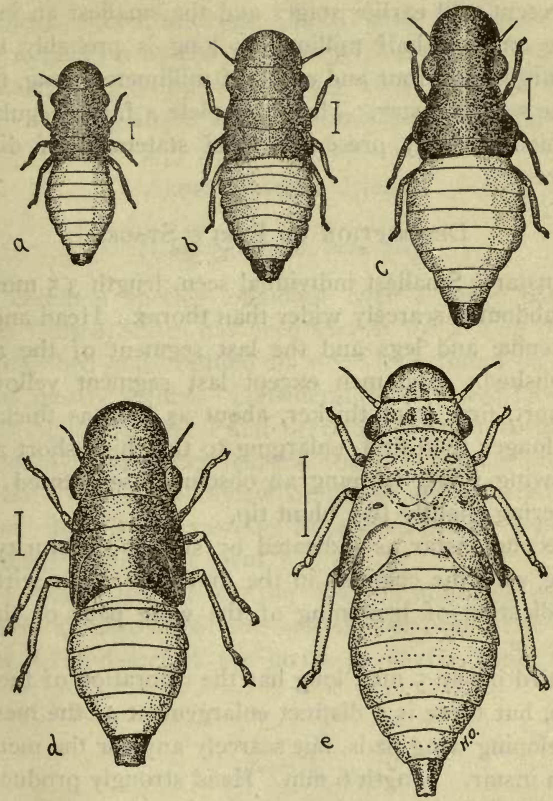


Fig. 41. *Aphrophora parallela a, b, c, d, e,* 1st, 2nd, 3rd, 4th, 5th instars. All enlarged. (Original.)

The earliest nymph collected in 1914 was a partly grown one secured by Mr. Newman June 19th, evidently representing the next to the last instar as all the later and larger nymphs showed a different color pattern. The date of egg hatching is therefore uncertain, but is probably during the last of May or early in June. The nymphal growth must be fairly rapid as individuals of the last instar occurred in early July and the first adults were observed on the morning of July 15th, one male being caught and another observed. At the same time one of the earlier instar forms was observed but at this time nearly all were in the preimago stage.

For the summer of 1916 which was late and the insects probably delayed in development, specimens were secured June 14th, that represent still earlier stages and the smallest an individual but three and one-half millimeters long is probably the first, while a larger one, four and one-half millimeters long, may represent the second instar. These complete a fairly regular series from which we may present a brief statement of distinctive characters.

Description of Early Stages.

First instar. Smallest individual seen, length 3.5 mm. Body slender, abdomen scarcely wider than thorax. Head and thorax with antennæ and legs and the last segment of the abdomen black polished. Abdomen except last segment yellow. Antennæ short, first joint thicker, about as long as thick, second scarcely longer than first, enlarging to tip, third short and with the following joints forming an obscurely segmented terminal part, tapering slightly to a blunt tip.

The second instar as indicated by size and maturity is 4.25 mm. long with the color as in the first instar, but with a very slight indication of beginning of the wing pads of the mesothorax.

The third instar 5 mm. long has the coloration of the preceding stage, but there is a distinct enlargement of the mesothorax into developing wing pads, but scarcely any for the metathorax.

Fourth instar. Length 6 mm. Head strongly produced semicircular from the base of the antennæ. A transverse suture across head, touching bases of antennæ. Mesothoracic wing pads extending back and enclosing metathorax and nearly touching base of abdomen, metathorax strongly concave behind the wing pads, not specially developed.

Color: Head and thorax including wing pads fuscous or nearly black, shining. Segments of the abdomen except the terminal one yellow-white, terminal segment black, tubular, legs black, tips of femora paler. Beneath; front black, lower part of face, legs and central stripe of abdomen brown, sides of abdomen, segments 1 to 5 orange red. (See fig. 41 *d.*)

Final instar. Length 11 mm., width 4 mm. Yellowish white with brown spots, brown eyes, ocelli in brown spots. A pair of spots on the prothorax, median and lateral spot on scutellum, part of mesothorax, the border and a pair of spots near center and the hind borders of the wing pads dusky; terminal segment black. Antennæ, eyes, tip of beak, and tarsi blackish. Ventral expansion of the pleurites giving a broad channel beneath, narrowing to tip where they form the leaf-like plates used in enclosing air to form the bubbles. (See fig. 41 *e*.)

ALDER SPITTLE INSECT.

(*Clastoptera obtusa* Say.)

This common species abundant over a large part of the northern United States has been known for a long period and while described and credited to alder it is found on a variety of plants mostly shrubs. Considerable confusion has occurred in its classification and Fitch described certain forms as *pini* and *testacea* from rather marked forms occurring on different plants, but Ball in his review of the group referred all these to *obtusa*. No distinct varieties have been clearly demonstrated as restricted to any host plant.

Linter Fifth Report of the State Entomologist of New York gives an account of the species based on larvæ occurring on alder. He describes the larvæ as nearly white with long legs which were moved rapidly in walking. The pupæ (last nymphal instar,) which had but recently undergone their transformation, show but little coloring, especially on their wing pads. With increased age they become more deeply colored, and they are olive-green on their thorax, wing cases and legs."

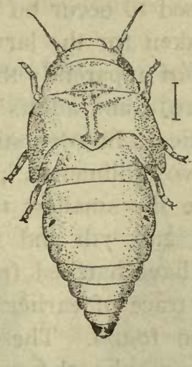


Fig. 42. *Clastoptera obtusa* Say. Nymph of last instar. Enlarged. (Original.)

While the observations of this season add little to the past records, the fact that specimens were bred from white birch and hazel seems to make a record worth while.

Our specimens were taken as last instar nymphs on July 25th at which time they were beginning to change to adults and adults have been common on various plants since to early August. See fig. 50, *e* and *f*.

Records carry the species as adult as late as Sept. 5th, so it may be considered certain that there is a single generation in this latitude and that the winter is passed in the egg form, the eggs hatching in spring or early summer, probably in June or early July, and the larval stages are passed rapidly.

DOG-WOOD SPITTLE INSECT.

(*Clastoptera proteus* Fitch.)

As the specific name implies this species is extremely variable and occurs in several forms, the more common ones being black in color with bright yellow cross bands on the thorax, in some cases with bright yellow spots on the base of the elytra and in others without these spots. See fig. 50, *g, h,* and *i*.

The species is supposed to occur on a variety of plants, but at Orono it has been taken for the larval stages, especially on the dogwood. Nymphs of apparently the final stage were taken during the summer of 1914 and adults were reared from these of both the color varieties. In 1916 still younger nymphs, the smallest found about two millimeters in length, were taken on dogwood and these are the smallest that have been secured. These were taken July 2nd, 7th and 10th and represent evidently individuals that have hatched from eggs that have survived the winter as no trace of earlier generation or of hibernating females has been found. These earlier nymphs agree closely with the older nymphs observed in 1914 except that the head and thorax are nearly black or solid dark olive green, while the abdomen is clear white or a very light greenish white. The beak extends to the hind coxæ and is dusky greenish olive, as are also the legs which are of about uniform size, or the hind ones possibly a trifle the larger.

Five fairly distinct sizes or forms representing probably as many stages are included in the series, but there is very little difference in them except in size, the greater amount of the dark color and the appearance of the wing pads.

Evidently they pass by easy gradations from one instar to another. Probably the moults take place within the froth masses as occasionally moulted skins may be found in the froth masses, but the nymphs appear to move readily from the froth if disturbed and start a new mass at another point. This habit of froth forming is so strong that they will begin the liberation of air bubbles in the balsam solution if placed in it alive for mounting.

The difficulty of securing newly hatched individuals is obvious since the only indication of occurrence is from the masses of froth and these do not appear until the young have fed and presumably have attained some increase in size.

The smallest individuals represent, therefore, probably advanced individuals of the first instar or possibly newly moulted individuals of the second instar. They are about two millimeters long, the head, prothorax, and mesothorax, with legs, antennæ, and last segment of the abdomen dark olive green, the metathorax and abdomen except last segment, greenish white or nearly pure white. There is no trace of enlargement for the wing pads and the metathorax is very short and inconspicuous.

The second size of individuals, probably second instar, show dark color on the metathorax and the angles of meso- and metathorax appear scarcely swollen.

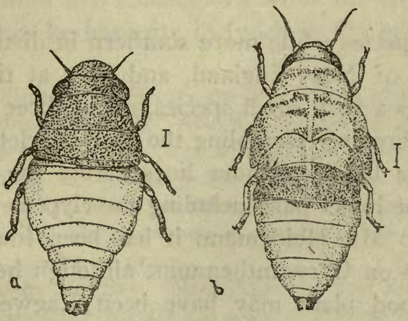


Fig. 43. *Clastoptera proteus* Fitch. Nymphs of 2nd or 3rd and final instar. Enlarged. (Original.)

The next in size, the third instar (?) show extension of mesothorax into the beginning of wingpads, but no perceptible pads on the metathorax. The dark color extends on to the first, second, and middle of the third abdominal segments, but is uniformly dusky on pro- meso- and metathorax.

No distinct separation of fourth and fifth instars has been made, but individuals referred to these differ in having less solid dark marking on the thorax and more extension of color on the abdomen. The wing pads are much more developed, and in the more mature forms extend on to the base of the abdomen. These mature forms, which are about three and a half millimeters in length, give rise to the adults, the appearance of adults coming the latter part of July.

Putting the various records together, it appears that the eggs remain over winter, the nymphs appear in late June, mature by the latter part of July and the adults presumably lay eggs during the latter part of the summer. There seems very little probability of a second brood in the latitude of Orono.

While these insects sometimes occur in considerable abundance and their food plants are often utilized as ornamental shrubs there is little danger of their becoming so serious a pest as to require any particular treatment. Indeed so far as observations go they seem pretty generally confined to the bushes, growing in their natural habitats and have not been taken upon bushes growing under cultivation.

CLASTOPTERA XANTHOCEPHALA GERM.

This small species while more southern in distribution occurs in some parts of New England, and may at times be found in Maine. It is a very small species, about three mm. long, and black or dark brown, resembling the black varieties of *proteus,* but differing in having slender lines across the upper part of the face and the lower part including the clypeus is black.

According to Mr. Heidemann it has been found during the nymphal stages on Chrysanthemums, although he surmises that the original food plant may have been Ragweed. In either case it can hardly be counted as of any particular economic importance in Maine.

Philaronia bilineata Say.

Another species which may be mentioned as belonging to the Maine fauna, although it has not been found in any abundance in the State, is the two-lined spittle insect *Philaronia bilineata* which is a common species through the northern part of the country from the White Mountains to the Rocky Mountain region. It is a little larger and more robust than *Philaenus lineatus* but much like it in general appearance. It has been taken at Fryeburg in the western part of the State by Mr. C. P. Alexander. The species has never been treated as of special economic importance and it is evidently too rare in Maine to need economic attention, but it often occurs in large numbers on the vegetation of the plains in the Dakotas and Montana.

CERCOPIDAE OCCURRING IN MAINE.

A list of the species of this family known to occur in the state may be of service in connection with the study of the leafhoppers (Jassoidea) and the studies of the life histories of some of the more important species from an economic standpoint.

The froghoppers are recognized by the conspicuous circle of spines at the tip of the hind tibiæ and the species occurring in this region are mostly rather small insects of modest colors, and the young are well known on account of the masses of froth in which they are enclosed.

The tree living or shrub living species are included in the genera *Aphrophora* and *Clastoptera* while the species occurring on grasses or low herbage are included in the genera *Philaenus* and *Lepyronia*.

Aphrophora parallela Say. Occurs on pine, often abundant.

Aphrophora saratogensis Fitch. Also a pine species is less frequent.

Aphrophora quadrinotata Say. Not abundant in collections so far.

Philaenus spumarius L. A very abundant species in meadows and mixed vegetation, living on other plants than grasses.

Philaenus lineatus L. Very common in meadows and grass land living on various species of grass.

Lepyronia quadrangularis Say. Much less common here than the preceding species but evidently not a grass feeding species.

Philaronia bilineata Say, Fryeburg. (C. P. Alexander)

Clastoptera obtusa Say. A common species on alder, etc.

Clastoptera proteus Fitch. Common on dogwood.

Clastoptera xanthocephala Germ.

Of these species only the *Philaenus lineatus* and *Aphrophora quadrinotata* have been given a record for Maine in Ball's Monograph of the North American species, but *spumarius* is recorded for Nova Scotia and "New England States."

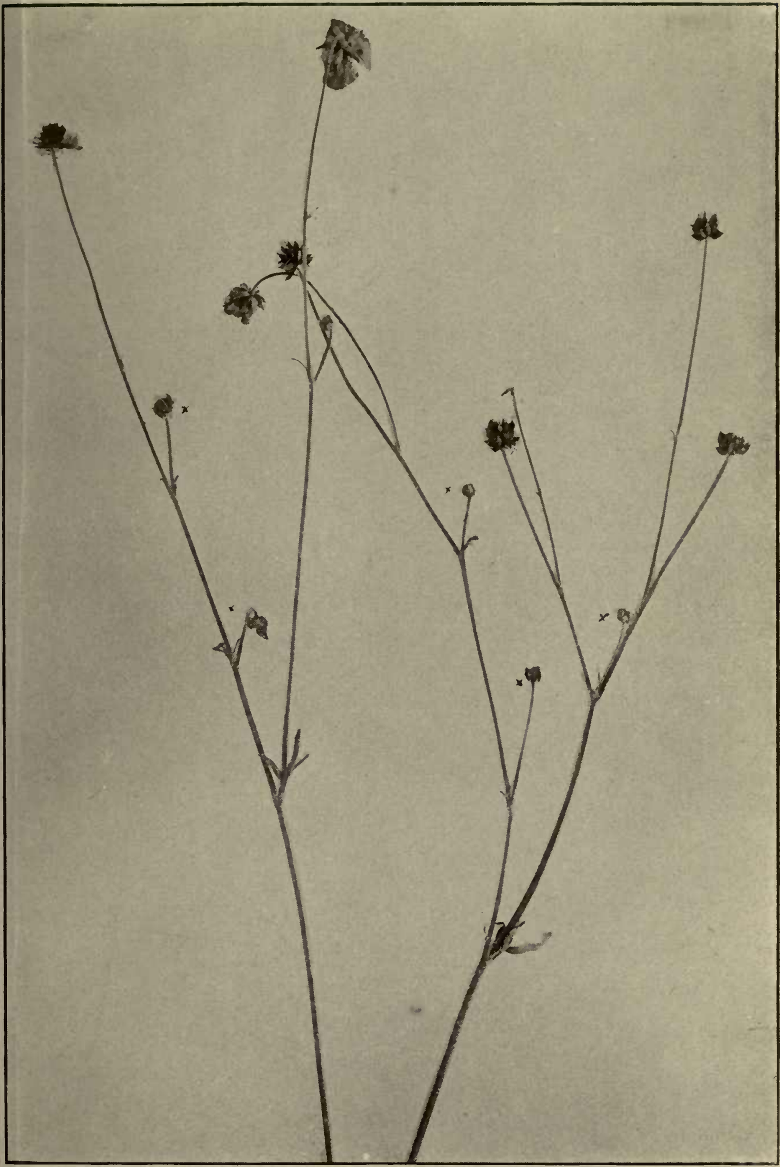
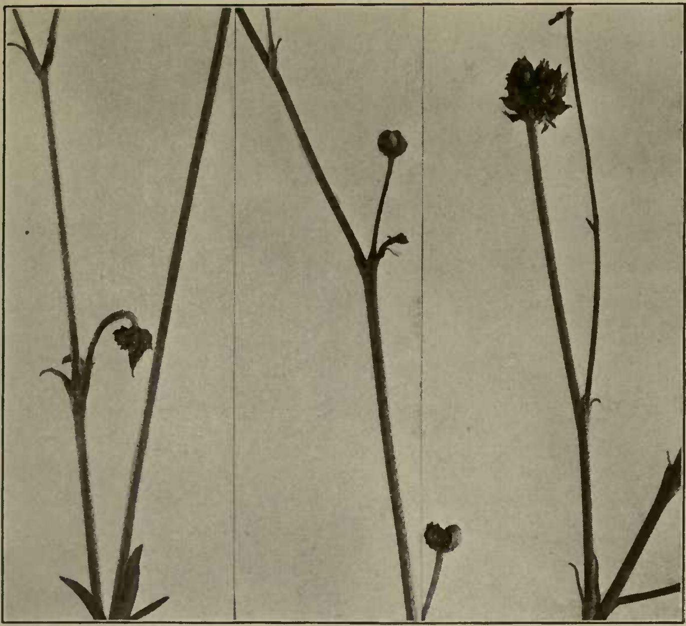


Fig. 44. Buttercup affected by *Philaenus spumarius.* The shriveled blasted heads are indicated by the x. (Original photograph.)



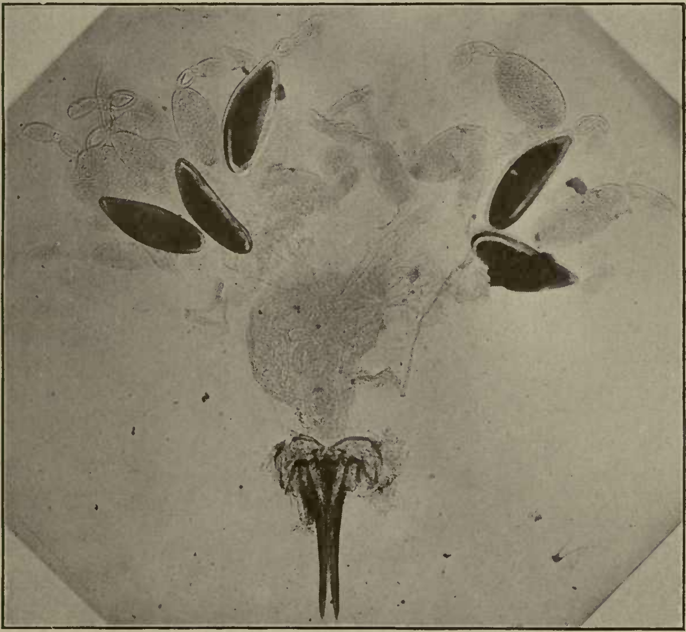


Fig. 45. Buttercup heads enlarged showing the blasting due to attacks of the Froghopper *Philaenus spumarius*. Fig. 46. Female reproductive organs of *Philaenus spumarius* showing ovary with undeveloped, partially developed and mature eggs, the latter appearing very black, with shell. Below these and connected with the oviduct is the circular spermatheca and at bottom the ovipositor. (Original photographs.)

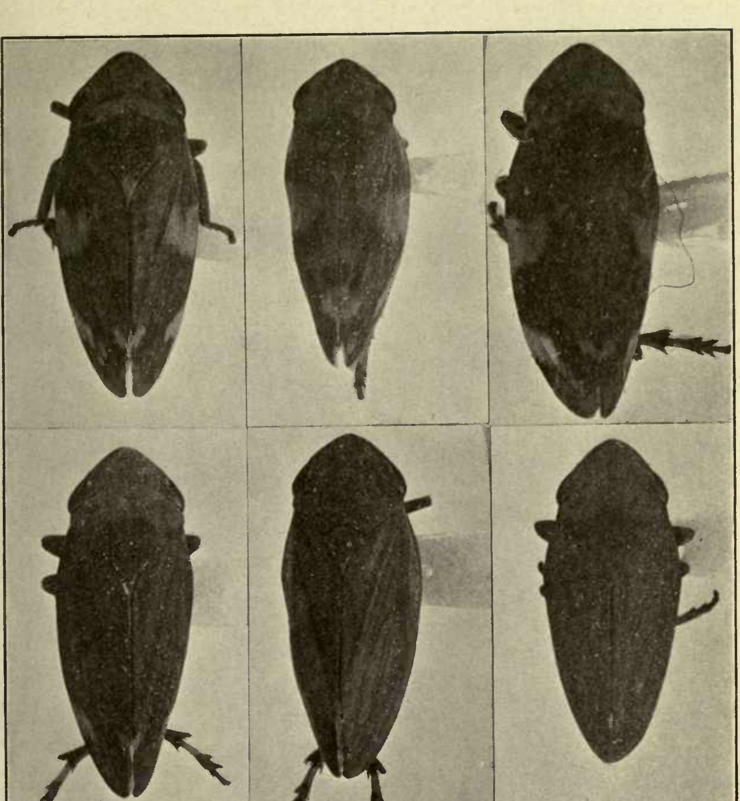


Fig. 47. Varieties of *Philaenus spumarius.* 1, 2, 3, var. *fasciatus;* 4, 6, *leucocephalus;* 5, *pallidus;* 7, *lineatus;* 8, nymph in final (fifth?) instar; 9, dark form of *leucocephalus.* (Original photograph.)

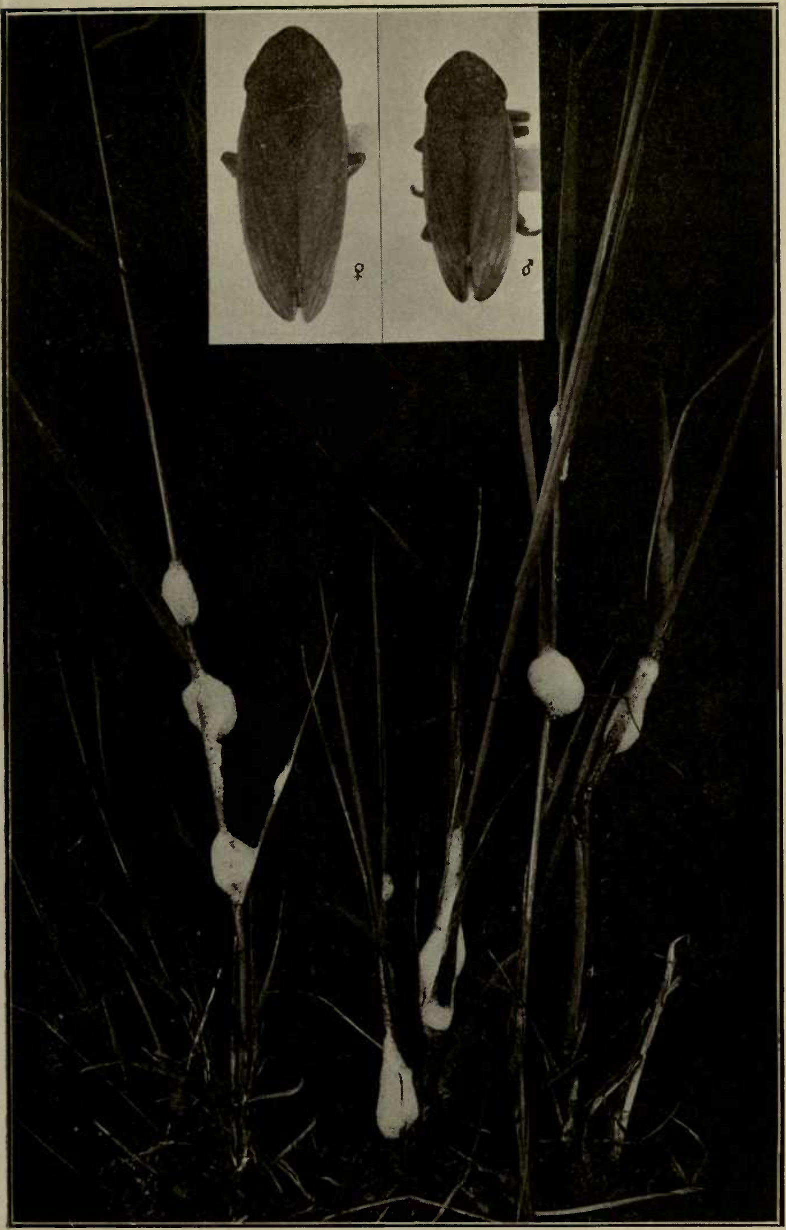


Fig. 48. *Philaenus lineatus.* Male and female above. Grass stems showing froth masses attached about natural size. (Original from photographs.)

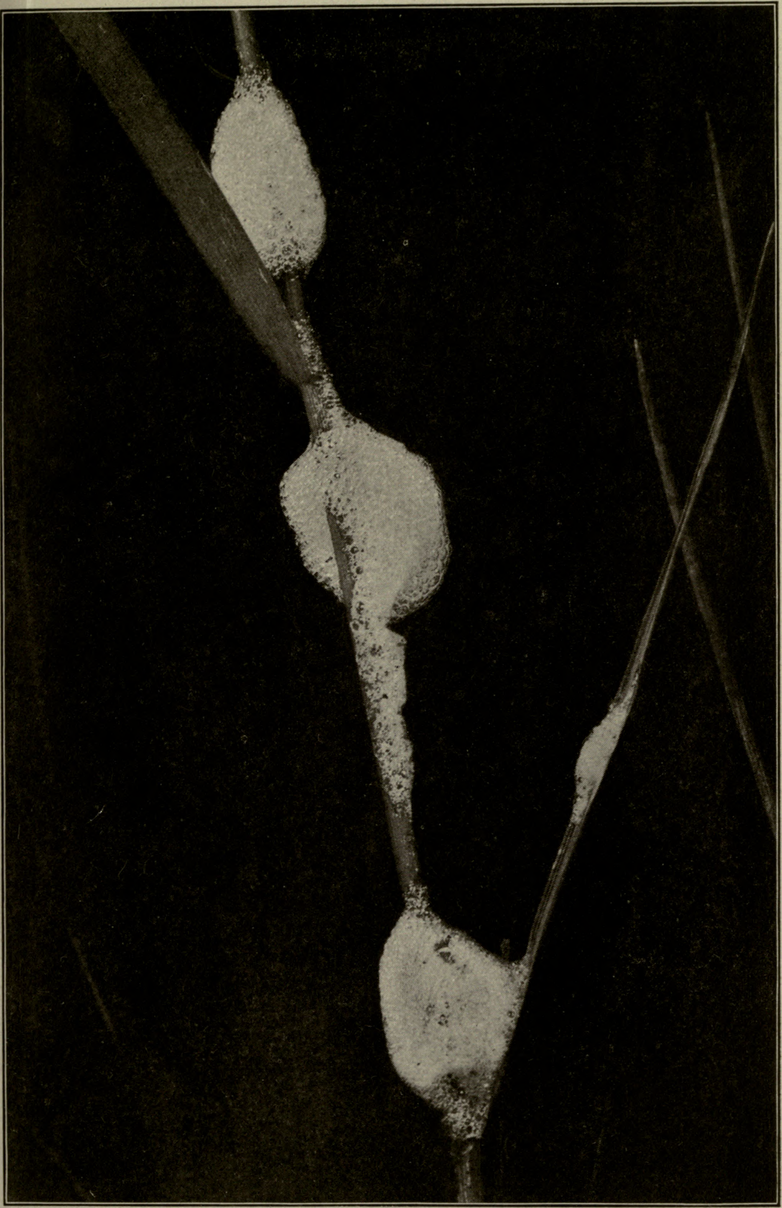


Fig. 49. Froth masses of *Philaenus lineatus* enlarged about three diameters. (Original from photograph.)

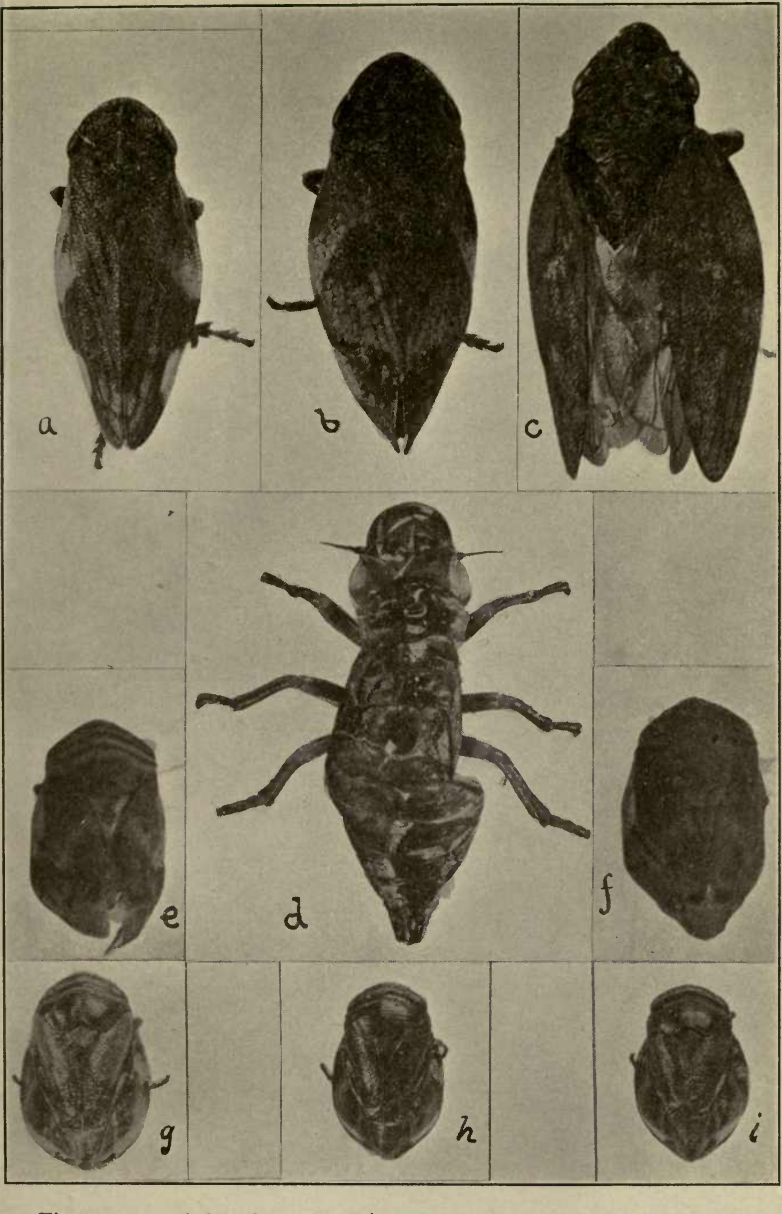


Fig. 50. *a, Aphrophora quadrinotata; b, Lepyronia quadrangularis; c, Aphrophora parallela; d A. parallela.* Nymphal molt from last instar; *Clastoptera obtusa* Say; *e,* male; *f,* female; *Clastoptera proteus* Fitch, *g,* female; *h, i,* two varieties of male. (Original.)

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN 256 **NOVEMBER, 1916**

ELM LEAF ROSETTE AND WOOLLY APHID OF THE APPLE.

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†In collaboration with U S. Department of Agriculture.

BULLETIN 256.

ELM LEAF ROSETTE AND WOOLLY APHID OF THE APPLE.*

Schizoneura lanigera (*americana* in part).

EDITH M. PATCH.

White masses looking like patches of thick mold often occur on apple trees, especially about pruning wounds or other scars on the trunk and branches and upon water sprouts. Beneath this substance are colonies of rusty colored or purplish brown plantlice known as "woolly aphids" on account of the appearance of white covering which is, however, really composed of waxen filaments.

The species is common in Maine on hawthorn, mountain ash, and Baldwin and some other varieties of apple.

It is one of the migratory aphids and passes part of its life cycle upon the elm,** as is explained in the following treatment. It should not however, be confounded with those woolly aphids found upon alder† and maple,‡ as the woolly aphid of the apple cannot live upon those trees.

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*Papers from the Maine Agricultural Experiment Station: Entomology No. 91. The work upon which this bulletin is based was for the most part completed in 1913 and published by this Station as Bulletin 217, which is now out of print. As the interest in the insect concerned continues and as the discovery of its annual migration from elm to apple was first recorded by this Station, it seems desirable to print this revised edition of Bulletin 217, containing such changes as bring the subject down to date. CHAS. D. WOODS, *Director.*

**There are other elm aphids belonging to this same genus which do not migrate to apple.

†*Pemphigus tessellata* (*acerifolii.*)

‡*Pemphigus tessellata* (*acerifolii*) and *Pemphigus aceris.*

Habits and General Discussion.

The woolly aphid occurs upon the apple as a bark feeder and is found upon branches, roots, and tender places on the trunk. These insects are covered by a white flocculent waxy secretion given off as fine filaments through pores in the skin and their colonies are thus readily detected by the masses of white "wool" which renders them conspicuous. Figs. 58 and 67.

On the roots its attacks induce enlargements and in the creases of these malformations the root form occurs in clustered masses. The injury to the trees is due both to the sucking up and exhaustion of the vital plant juices and to the poisoning of the parts attacked, as indicated by the consequent abnormal growths. Fig. 66.

The damage is particularly serious in the case of nursery stock and young trees and is less often important after the tree has once become well established and of some size, though it may be troublesome then, too. Where this insect is abundant all the roots of a young tree to the depth of a foot or so become clubbed and knotted by the growth of hard fibrous enlargements with the results in a year or two of the death of the rootlets and their ultimate decomposition with subsequent disappearance of the galls and also of the aphids, so that after this stage is reached the cause of the injury is often obscure.

On the trunks the presence of the aphids results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots, they collect, particularly in the axils of the leaves, often eventually causing them to fall, and on the tender growth of the stems. The damage above ground, even when insignificant, is useful as an indication of the probable existence of the aphids on the roots. A badly attacked tree assumes a sickly appearance and does not make satisfactory growth, and the leaves become dull and yellowish, and even if not killed outright it is so weakened that it becomes especially subject to the attacks of borers and other insect enemies.

The common forms both on the roots and above ground are wingless aphids, not exceeding one-tenth of an inch in length, of a reddish-brown color, and abundantly covered, especially in those above ground, with a flocculent waxy secretion. Fig. 63.

In August and later, among the wingless ones, winged females appear in abundance. Fig. 62. They are little, clear-winged aphids which look nearly black unless carefully examined when the abdomen is found to be dark yellowish red or rusty brown. These are the fall migrants that leave the apple and seek the elm before giving birth to the generation of true sexes,—minute, wingless, beakless creatures, the female of which deposits a single "winter egg," within a crevice of the elm bark.

The flight of the fall migrants away from the apple is apparently a common observation of all who have studied this species either in this country or abroad,* but it is only recently that the significance of this flight has been appreciated, it having been thought previously to be merely a dispersal from one apple tree to another.

Where woolly aphid colonies are very thick, the true sexes and the winter eggs are sometimes found upon the apple tree. That such occurrences are accidental seems probable as fall migrants of most species will occasionally dispose of their progeny before reaching the appropriate winter host.

A record of such an occurrence is to be found in the *Report of the Entomologist of the United States Department of Agriculture for the year 1879* by J. Henry Comstock. On page 259 of this Report, Dr. L. O. Howard recorded his observations made in a little orchard of Russian apple trees then on the grounds of the Department of Agriculture at Washington, his statement concerning the winter egg being as follows:

"The winter egg was found on several occasions during the winter in crevices of the bark over which a colony had been stationed during the summer. It was a rather long ovoid, measuring .322 mm. (.125 inch) in length and was very similar to the winter egg of *Colopha ulmicola* (Fitch), as described by Riley in Bulletin No. 1, Vol. V, Hayden's Survey.

"This egg was laid, as Professor Thomas supposes, by a wingless female, differing from the ordinary agamic form to a certain extent. These females we only know from finding their skins around the winter egg, since they often die without depositing it. The males we have not seen."

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*Dr. O. Schneider-Orelli records also the development of winged forms in June.

Sonderabdruck aus Heft 7/8 des XII. *Bandes der Mitteilungen der Schweizerischen Entomologischen Gesellschaft.* 1915.

Mr. A. C. Baker of the Bureau of Entomology wrote me (Nov. 20, 1912): "I found that when the colonies are very thick the alate forms often stay on the apple and I have found on one tree a number of winged ones with the abdomen shriveled as it is after producing sexes. I saw some sexes crawling up and down the small twigs and though I have not yet seen any eggs which they laid they no doubt would lay eggs. On one occasion I found sexes on an apple leaf which had fallen to the ground."

That such occurrences are not a part of the ordinary life cycle is indicated by the usual wholesale flight of the fall migrants.*

On the elm the stem mother, which hatches from the overwintering eggs sheltered probably in rough crevices of the bark, appears early in the spring and may be found in Maine before the middle of May stationed on the partly opened leaf buds.

The beak punctures on the rapidly expanding new leaves cause an unevenness of growth which forms a protection for the aphid. By the last of May the earliest of these wingless stem mothers are mature and found in the deformed elm leaves (Fig. 59) producing the next generation. The antenna is shown in Fig. 68.

These nymphs, like the stem mother, are a wingless form and they become fully developed about the tenth of June. They have wax glands, of the type shown in Fig. 61. Their progeny are the third generation and attain wings. These winged aphids are known as the spring migrants.

It takes three weeks or slightly more or less, beginning about the twentieth of June, for all the individuals of this third generation to get their growth so that the migration covers a considerable period. The deserted rosette or leaf cluster at this time looks like Fig. 60. During this time these winged aphids may be found alighting on the leaves of apple, mountain ash, and hawthorn. They creep to the under side of the leaf and remain there while they give birth to their progeny (i. e., the fourth generation). These young, before they feed at all, crawl to the stem of the water-shoots, or to some tender place on the bark often near a pruning wound, and there start the colony on the summer host plant. Such a young colony shown in Fig. 67, was on a mountain ash in Orono of which I kept a record during the season of 1912.

---

*1904. Alwood, Wm. B. Circular in Relation to Some Injurious Insects and Plant Diseases. Special Bulletin (C. P. C. 45), Va. Exp. Sta.

1908. Gillette, C. P. Notes and Descriptions of Some Orchard Plant Lice, of the Family Aphididæ. Journal of Economic Entomology, Vol. 1, pp. 306-308.

1909. Börner, Carl. Kaiserliche Biologische Anstalt für Land-und Forstwirtschaft, August.

1913. Reh, L. Der Praktische Ratgeber im Obst—und Gartenbau, February 2.

The main trunk of this tree was dead nearly to the ground, but 12 vigorous shoots had grown up measuring about 5 feet each. On June 28 this mountain ash had about 150 woolly masses of nymphs grouped on the stem at the leaf axils. These nymphs ranged from very tiny ones to half grown insects, none being mature at that date. One such woolly mass contained 155 individuals of various sizes. (See Fig. 67). On the ventral surfaces of the leaves of this mountain ash were stationed many elm leaf migrants producing there their broods of nymphs which could be seen, with the hand lens, to be augmenting the woolly masses on the stem. Collections of these migrants thus stationed were made as follows:—July 2, 88 migrants; July 3, 211 migrants; July 5, 92 migrants; July 8, 54 migrants; July 9, 80 migrants; July 10, 33 migrants; July 11, 14 migrants; July 12, 3 migrants. Only living individuals were collected, dead ones being brushed off and discarded in the counts. Microscopic examination showed them to be identical with winged forms collected in elm leaf. Two large elm trees with leaves well stocked with this species stood about a rod distant.*

In this connection it may be of interest to record a forced migration test. On June 21, 1912, I placed several hundred elm leaf migrants at the base of water shoots of an uninfested mountain ash on the Campus. As the migrants are much more docile about sundown than earlier in the day this was done about 7 P. M. They moved but little, most of them creeping to the ventral side of a leaf and remaining there; and during the night producing nymphs which sought the leaf axils of the water shoots so that by the afternoon of June 22, the tiny nymphs had already fed enough and secreted enough white wax to give the typical "woolly" appearance to the young colonies. These and the progeny thrived on the mountain ash in a perfectly normal way.

On June 17, 1913, a laboratory cage check was started with migrants from an elm rosette. The winged forms ready to desert the elm leaves were caged with a seedling mountain ash. Their progeny settled in woolly masses on the stem of the seedling and are shown in Fig. 58. By July 2 these had matured and were producing young which in turn had matured and were producing nymphs on July 26. This third mountain ash generation (sixth generation beginning with the stem mother) proved too much for the little seedling which was so nearly dead by August 10 that the last of the aphids perished at that time.

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*Previously recorded in Journal of Economic Entomology, Vol 5, No. 5, 1912.

Schizoneura americana is a name which until recently has been commonly applied to two distinct species by American entomologists.

One of these species inhabits the leaf cluster or aphid rosette of the American Elm (Figs. 59 and 60). This migrates to apple, several varieties of mountain ash (*Pyrus* sp.) and to hawthorn (*Crataegus*), where it was familiar as *lanigera* long before its identity with the aphid of the elm rosette was suspected. The life cycle of this species so far as personally ascertained by the writer is recorded in the present paper. This species is found in Maine, Missouri, Colorado* and doubtless all the way between. Like other aphids it is fluctuating in its abundance, being conspicuous some years and comparatively rare during other seasons.

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*That Messrs. Gillette and Bragg were mistaken in their opinion that the rosette aphid in Colorado did not migrate to the apple in accordance with its habit in Maine (*Journal Economic Entomology, Vol. 8, p. 100*) is shown by the observations of Mr. Maxson (*Entomological News, Vol. 26, pp. 367-368*). Although Professor Gillette has not yet published his later observations, so far as we know; that they agree with those of Mr. Maxson is indicated in a letter from him to the writer under date of June 25, 1915, from which the following paragraphs are quoted:

"You will be interested to know that the rosette form of the elm *Schizoneuran* is very common about Fort Collins this year, and the winged forms are now leaving the leaf clusters in great numbers, and for the first time since we began the study of this insect, we find the lice locating in considerable numbers upon the under side of the leaves of apple trees.

"In many instances we are able to find the young that they are depositing, and in many instances, also, it seems probable that a colony of young lice in the axils of the leaves are the product of these winged lice from the elm. So it begins to look as though we shall have to admit that there is a natural migration of this elm *Schizoneuran* to our apple trees.

"We had been able, repeatedly, to get these lice to take in small numbers in our breeding-cages, and I find that last year Mr. Maxon of Longmont had found this louse going to the apple in the field, but until a few weeks ago, he had not communicated the fact to me. It really looks now as though our observations here would fully confirm your observations in Maine."

The experiments of Mr. Baker proved that in the localities in which he worked the elm is the winter host of *lanigera* (*Report No. 101, U. S. Department of Agriculture, Office of the Secretary. 1915*). The life cycle of this aphid, therefore, as discovered for Maine by the writer, does not seem to be exceptional for America.

The other species to which the name *Schizoneura americana* has been commonly applied is the aphid discussed in Bulletin 241 of this Station. Since the name *lanigera* takes care of the rosette species on elm as well as on apple, *S. americana* seems to be left conveniently for the aphid curling or rolling the leaf of the American Elm (Fig. 45 of Bulletin 241). Riley's description of the leaf deformations caused by *S. americana*† indicates clearly enough that he originally applied this name to both these species as his successors have certainly done until recently; and the synonomy "*Schizoneura lanigera* (*americana* in part, of authors)," correctly designates the "rosette aphid" of the elm.

There are apparently 3 summer generations of progeny of the elm leaf migrants upon the apple in Maine,—two apterous generations followed by a generation part of which, the fall migrants, become winged and leave the apple and part develop into apterous forms and remaining on the apple give birth to nymphs which while still young seek protection at the base of the tree for the winter and are known as the hibernating nymphs.

It is the function of the migrants to seek the winter host and there give birth to the true sexes. These are the tiny yellowish brown egg-laying females and the still smaller pale yellow males. Both sexes are wingless and with rudimentary mouth parts which are apparently functionless. One comparatively large yellow egg occupies nearly the whole abdomen of the female and with the deposition of this the cycle of the species closes,—or begins. It is too complicated a performance to follow easily but the outline on page 338 will be useful as a summary. Such a cycle with the annual migration to and from the apple with the elm serving as host for the first three spring generations is undoubtedly typical for *lanigera*. The hibernating nymphs which remain protected about the crown of the apple over winter and ascend to tender places on the bark before feeding in the spring give what looks like a "closed cycle" of apterous viviparous females persisting on the apple. How long such a colony could maintain itself on the apple without fresh material from the elm I do not know.*

---

†"Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf, but according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves."

I am certain that in Maine the natural enemies of the woolly aphid would cut its career short and that it would not assume the status of a pest of consequence if it did not shift its food plant. As it is, a two days quest in the vicinity of Orono early in September, 1913, failed to locate a single colony which was not well nigh demolished by chalcid parasites and the colonies of 1912 met a similar fate the preceding year by virtue of syrphus maggots. Lady bird beetles are also very active some seasons. While in the elm leaf this aphid is preyed upon by syrphus maggots, capsid bugs and lady birds.

As if the hibernating nymphs were not enough to bewilder one, the case of the woolly aphid of the apple is still further complicated by the root colonies which although hidden in their operations are really often much more pernicious than the colonies on trunk and branches. These root colonies ordinarily remain underground all the year round, apparently until the roots become too badly demolished for feeding purposes.

ECONOMIC STATUS.

The danger from the woolly aphid is greatest to nursery stock and young orchards. Mr. Marlatt (Journal of Economic Entomology, Vol. 4, pp. 116-117) in recording the use of American-grown apple seedlings says:—"Mr. F. W. Watson, of Topeka, Kans., in an article in the *National Nurseryman* for January, 1910, p. 437, on 'American-grown Apple Seedlings,' states that from twenty to forty million of American-grown apple seedlings are used in this country every year, the production of about a dozen nursery firms. The bulk of the seed used comes from France, and therefore is of the same stock as the imported French seedlings."

Mr. Lohrenz (1911) in recording observations on two-year-old nursery stock made at three nurseries containing respectively

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*We have an exact parallel in *Pemphigus tessellata* or the woolly aphid of the alder with a cycle including a spring migration from the maple leaf to alder and a fall or return migration to the maple and also a generation of hibernating nymphs remaining under leaves about the base of the alder during the winter and ascending to the stem before feeding in the spring.

about 30,000; 45,000; and 300,000 trees, states that he found from 20 per cent to 25 per cent of the trees infested by the woolly aphid.

In circular No. 20, Bureau of Entomology U. S. Department of Agriculture (revised edition 1908) the woolly aphid of the apple is characterized as "one of the worst enemies of the apple."

Mr. Alwood (1904) of the Virginia State Crop Pest Commission in his excellent account of this insect states "On nursery stock the woolly aphis is a most serious pest, and under some circumstances it ruins a large percentage of the apple trees in the nursery."

On page 5 of Bulletin 133 of the Colorado Experiment Station the following statement is made:

"If Colorado orchardists should vote their opinion as to what ought to be called the worst orchard pest in the state, it is very doubtful whether the codling moth, or the woolly aphids, would carry off the honors."

Although it would be easy to compile testimony of this character against the woolly aphid as an enemy to young apple trees from numerous and widely separated parts of our country, they would be chiefly a repetition of what has already been said.

During those seasons when the species is abundant it is also a serious pest on American elm. Some springs in the vicinity of Orono practically every branch of many trees is tipped with an unsightly cluster of deformed leaves or "rosette" gall. Such an infestation, to say the least, mars the beauty of a large tree and is a heavy handicap for a young one.

LIFE CYCLE OF WOOLLY APHID OF APPLE.

(Exclusive of root forms.)

ELM: Primary Host.

EGGS.
(Under bark all winter)

STEM-MOTHER.
(first generation in leaf.
Apterous viviparous females).

SECOND GENERATION.
(apterous viviparous females
in leaf).

SPRING MIGRANTS Migrates to apple . . . .
(third generation. Alate viviparous).

Apple: Alternate Host.

NYMPHS.
(Hibernating young migrating to trunk or branches in early spring)

SEVERAL GENERATIONS.

FOURTH GENERATION.
(apterous viviparous females).

FIFTH GENERATION.
(apterous viviparous females).

Migrate to elm . . . FALL MIGRANTS.
(Alate viviparous
parthenogenetic
females, mature
Aug.-Sept.
sexuparae.)

APTEROUS OVIPAROUS FEMALES
AND APTEROUS MALES.

EGGS.
(under bark all winter).

APTEROUS VIVIPAROUS PARTHENOGENETIC FEMALES, mature in Aug.-Sept.

HIBERNATING NYMPHS
(protected during winter
about crown of tree).

STRUCTURE KEY.

WOOLLY APHID OF APPLE.

A. Apterous forms. Antennæ without annulations.

B. Females.

C. Viviparous.

D. Antenna typically 5-jointed, Fig. 68. Wax glands not of type shown in Fig. 61. First spring generation hatched from over-wintering egg and found in elm rosette early in June..................*Stem Mother.*

DD. Antenna 6-jointed. Fig. 68, No. 80. Wax glands as shown in Fig. 61 and Fig. 68, No. 80. Progeny of stem mother developing in rosette in June ....*Second Elm Generation.*

DDD. Antenna 6-jointed. Fig. 68, No. 82. Wax glands of same type as those shown in Fig. 61. On apple bark or water shoots ....*Summer Generations.*

DDDD. Structure about as with summer generations On apple roots all times of year.............*Root Generations.*

DDDDD. Young born late in fall and living over winter about crown of tree, apparently without feeding until spring, when they ascend to apple bark and attain their growth ....*Hibernating Nymphs.*

CC. Oviparous.

Antenna 5-jointed, Fig. 64. Minute beakless form which deposits the over-wintering egg. Rarely seen but easily obtained by imprisoning fall migrant in vial..*True Female.*

BB. Minute beakless form smaller and more slender than true female. Antenna 5-jointed. Fig. 65. Rarely seen but easily obtained, by imprisoning fall migrant in vial................*True Male*

AA. Alate forms. Antennæ with annulations.

B. Antenna typically with III as long as or longer than IV+V+VI. VI typically without annulations. Fig. 68, No. 81. Developing in June-July in elm rosette and migrating to apple, hawthorn and mountain ash. Progenitor of summer generations ....*Spring Migrant*

BB. Antenna much as in spring migrant, though usually shorter. VI typically with 2 or more annulations. Fig. 68, Nos. 83, 84, 85. Developing in fall in woolly colonies on bark of apple, hawthorn and mountain ash. Fig. 62. Progenitor of true males and females ....*Fall Migrant*

HABITAT KEY.

Woolly Aphids of the Elm.

A key to aid in distinguishing the woolly aphid of the apple from the other elm species with which it may easily be confused in the spring of the year.

A. Conspicuous woolly colonies on bark of *Ulmus americana.* Throughout the summer on young elms. No alternate host known. Widely distributed in America..............*S. rileyi.*

AA. Spring generations in elm leaves, causing various types of deformation.

B. Large baggy gall on *Ulmus campestris.* Alternate host unknown. European species. Taken in Connecticut in 1913 ....*S. lanuginosa.*

BB. Terminal leaf cluster or rosette (Figs. 59-60) on *Ulmus americana.* Spring migration to apple, mountain ash, and hawthorn. Maine to Colorado.................... ....*S. lanigera* (*americana* in part, of authors).

BBB. Leaf curl or roll type of deformation.

C. Leaf roll of *Ulmus scabra* and *U. campestris.* Antenna of winged generations with V and VI without annulations. Spring migration to gooseberry and currant. European species. In America found in California, Oregon and Maine (1913).......................*S. ulmi* (*fodiens*).

CC. Leaf roll of *Ulmus americana.* Second apterous spring generation with wax gland distinctly unlike those of Fig. 61. Spring migrant with antenna typically with III not longer than IV+V+VI. Alternate host *Amelanchier* the roots of which are infested.* Maine to California ....*S. americana* in part, of authors.

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*Bulletin 241. Maine Agricultural Experiment Station.

PREVENTIVE AND REMEDIAL MEASURES.

The foregoing account of the habits and characteristics of the woolly aphid will suggest certain measures to control it.

The protection of seedling apples from infestation by the woolly aphid while still in the nursery has heretofore been an exceedingly difficult matter it would seem from the amount of infested stuff that is yearly condemned. But with the knowledge that the source of danger lies in the migrants from the previously unsuspected elm leaf, it is seen to be possible to control the nursery stock by establishing nurseries at a safe distance from susceptible elm trees or clearing out the elms from the vicinity of large nurseries. As there are many places in the country where the elm is not at all abundant this would often be entirely practicable and where so would be the simplest and most effective method of protection. As it is the seedling trees that are most susceptible to injury and when attacked most seriously damaged by the woolly aphid a method of protection for the young trees while in the nursery is the most desirable.

The raising of the elms and apples in the same nursery is thus seen to be a hazardous proceeding and should be avoided.

Again young orchards of clean stock set in parts of the country where the elm is not grown should be successfully protected by excluding elms from the choice of shade trees. Indeed, the matter of alternate hosts of the aphid enemies concerned should always be borne in mind in planning the trees for an estate, and only one of the two hosts necessary for the life cycle of a migratory aphid planted, where the pest is a serious one.

It is desirable that data concerning the relative susceptibility of different varieties of apple should be accumulated with a view to using the more resistant for root stock, if otherwise practicable.

In dealing with infested apple trees the aphid masses on trunk and branch present no especial difficulty, and can be very readily exterminated by the use of any of the washes recommended for plant-lice, such as tobacco decoction, kerosene emulsion, a strong soap wash (Formulas A, B, C, D), the only care necessary being to see that the wash is put on with sufficient force and thoroughness to penetrate the covering and protecting cottony secretion. If the wash be applied warm, its penetration will be considerably increased.

An August spray to kill out colonies before the migrants fly and the hibernating young are produced is particularly desirable.

The much more important root feeders, however, are more difficult to reach and exterminate. The common recommendations are of applications of strong soap or tobacco washes to the soil about the crown, or soot, ashes, or tobacco dust buried about the roots; also similarly employed are lime and gas-lime.

Badly infested nursery stock should be destroyed, since it would be worth little even with the aphids removed.

Some nurseries are said to make a practice of "puddling" roots of infested stock, that is packing mud about the roots to conceal their condition. Before purchasing puddled nursery stock, the buyer should insist that the mud be washed off thoroughly so that the roots are exposed for inspection.

Proper cultural methods can hardly be overestimated in their value as a protection of young trees, as neglected orchards not only suffer heavily but serve as a breeding ground, dangerous to the neighboring trees.

Formula A—Tobacco Decoction.

Tobcco stems or tobacco dust..................	2 pounds
Water	4 gallons

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime of other alkaline substance should be added to the tobacco *while cooking*. Apply at once, or within a few days after making if possible.

Certain reliable extracts such as *"Black Leaf," "Black Leaf 40,"* and *"Nikoteen"* are on the market and can be secured through local druggists. (The Black Leaf preparations are manufactured by *The Kentucky Tobacco Product Company,* Louisville, Ky., and are carried by the Collins Hardware Company, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by The Nicotine Manufacturing Company, St. Louis, Mo., and can be secured from Joseph Brick & Sons, 47-54 N. Market St., Boston, Mass.).

Directions for use come with the products. There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in preparation of one gallon to sixty or sixty-five gallons of water. Careful sprayers have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of material used.

Nikoteen is a more concentrated abstract, 1 part being used with from 400 to 600 parts of water.

Black Leaf 40 is a concentrated solution of nicotine-sulphate and is widely and successfully used in large western orchards, at the rate of 1 part to 800 or 900 parts of water.

It is the common practice to add soap,—whale oil soap or good laundry soap at the rate of 2 bars to 50 gallons. This is to lessen the formation of drops, causing the spray to cover surfaces more in the form of thin film.

Better success is obtained by some by using a little lime instead of soap, the inert solid in suspension aiding the extract to "wet" and "stick" to the bodies of the aphids. For this purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

FORMULA B.—KEROSENE EMULSION.

Hard Soap	1-2 pound
Boiling Water	1 gallon
Kerosene	2 gallons

To prepare dissolve one-half pound of soap in one gallon of soft water by boiling; when well dissolved and still boiling hot, remove from the fire and add two gallons of kerosene, and agitate at once as briskly as possible. The emulsion is more readily made if the Kerosene first be heated by immersing the vessel containing it in a larger vessel of boiling water. *Never* heat the kerosene over a direct fire.

If large quantities are being made, a good way to emulsify is to use a force pump and spraying nozzle and pump the mixture as forcefully as possible back into the vessel containing it. If the emulsion is properly formed, the whole mass will appear much like whipped cream and will mix readily in water without a film of oil rising to the top.

As soon as emulsified, add twenty-seven gallons of water and use at once. This will make thirty gallons of the mixture, and such an emulsion will be one-fifteenth oil (or a 7 per cent emulsion). This is the strength ordinarily used for the destruction of insects upon plants. For larger or smaller quantities, prepare in the same proportions.

Sometimes the emulsion is not perfect and a little oil rises to the top. In such cases, if the last in the barrel or tank is pumped out upon the foliage, it is likely to burn it. So it is advisable, unless the emulsion is of good quality, to throw out the last few gallons, making no use of it.

It is best to dilute and apply kerosene emulsion as soon as it is prepared.

Avoid using alkali or any hard water in making the emulsion, as it will cause the oil to separate and rise to the top. Any clean, soft water will usually give good results.

FORMULA C.—MISCIBLE OILS.

There are several miscible oils upon the market which may be added directly to water forming a milky emulsion at once. In the preparation of any of these, such as "Scalecide," or "Target Brand Scale Destroyer" or "Killoscale," add the oil directly to the water with a little stirring. One gallon of the miscible oil in 30 to 50 gallons of water will make a mixture, which in most cases will be strong enough to kill plant lice, if thoroughly applied.

FORMULA D.—WHALE-OIL OR FISH-OIL SOAPS.

The so-called whale-oil or fish-oil soaps which are quite extensively used for the destruction of plant lice, will usually be effective if thoroughly applied in the proportion of one-pound of the soap to each six or eight gallons of water. There are numerous brands of these soaps upon the market. Among those that have been used quite successfully are Good's Whale-Oil Soap and Bowker's Tree Soap.

* * * * * * * * *

In recent years tobacco extracts have rapidly taken the place of other remedies for aphids, and well informed apple growers are using them almost to the exclusion of other insecticides. It should be remembered that this is a contact insecticide and kills only the insects actually touched. It is, therefore, necessary to be very thorough in the spraying

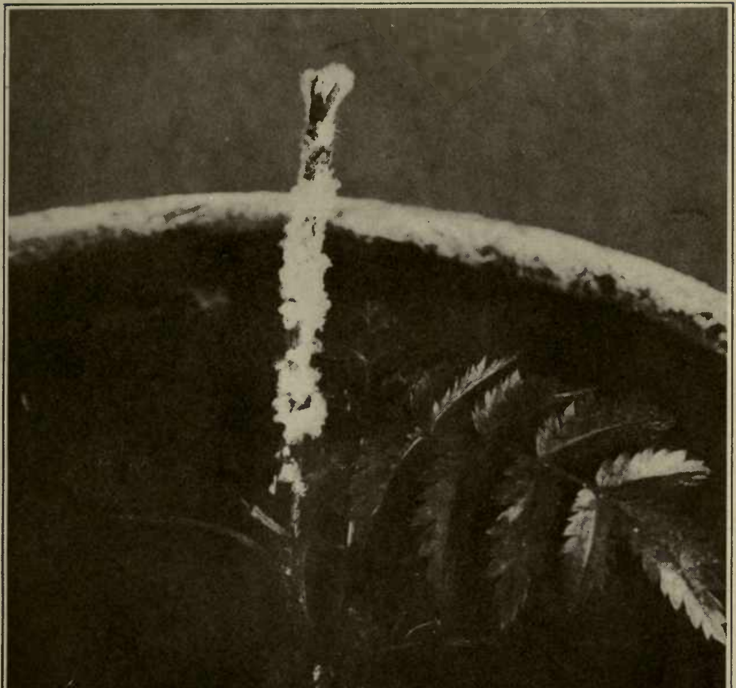


FIG. 58. Seedling mountain ash photographed June 25, 1913 to show colony of woolly aphids which are the progeny of migrants from elm leaf rosette caged with mountain ash, June 17, 1913. Two apterous generations matured on this seedling, but the third generation proved too much for the little tree which was so nearly dead by August 10 that the last of the aphid colony perished at that time.

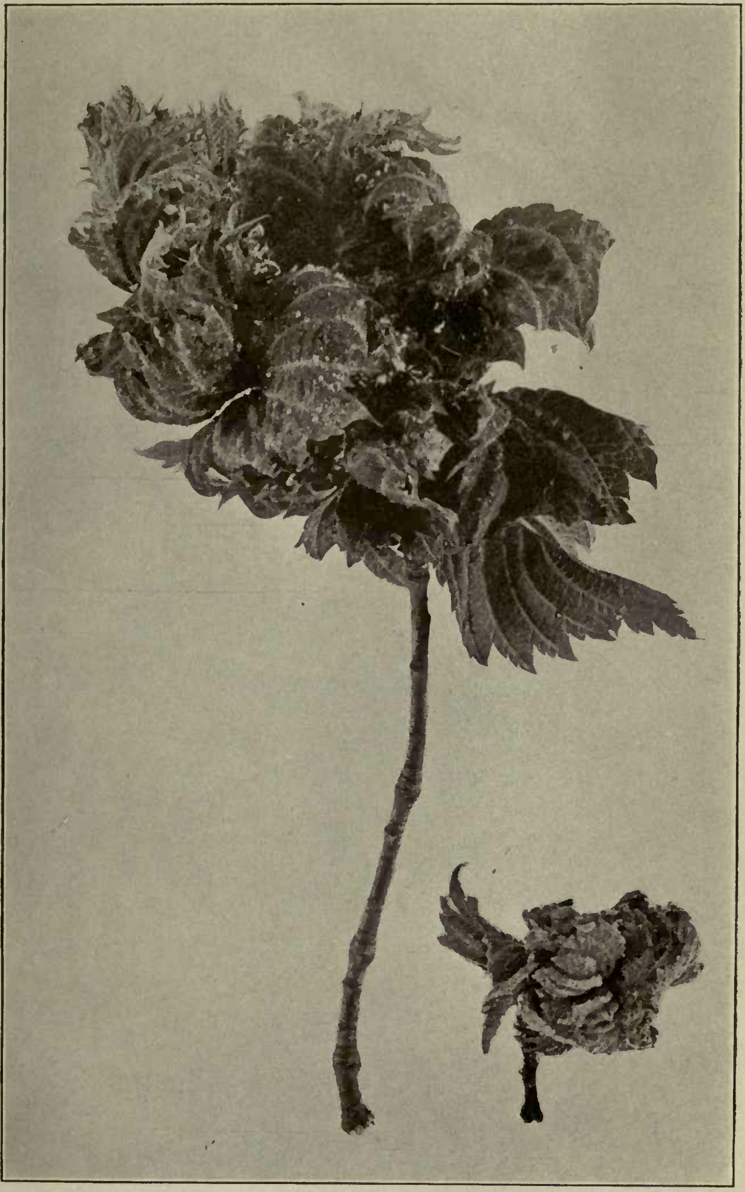


FIG. 59. Young rosette photographed June 6, 1913. Small picture at right.

FIG. 60. Old rosette photographed July 17, 1913.

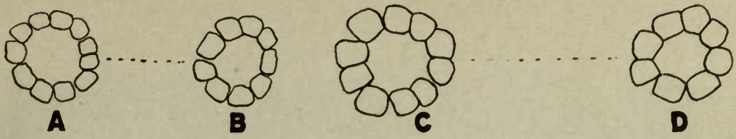
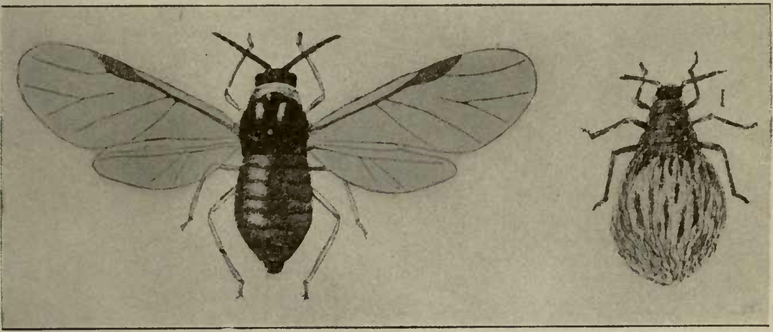
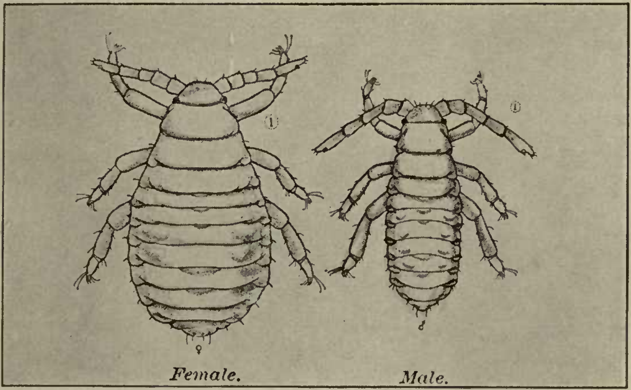


FIG. 61. Dorsal wax gland of rosette aphid, second generation. A & B, a pair on head. C & D, a pair on prothorax. Notice that the sections are not uniform in number as is often the case.



FIGS. 62 and 63. Woolly Aphid. Winged and wingless forms. Greatly enlarged. (After Marlatt.)



FIGS. 64 and 65. Mature sexual individuals of the Woolly Aphid,—the oviparous female and male. Real size shown in circles at right of figures. (After Alwood.)

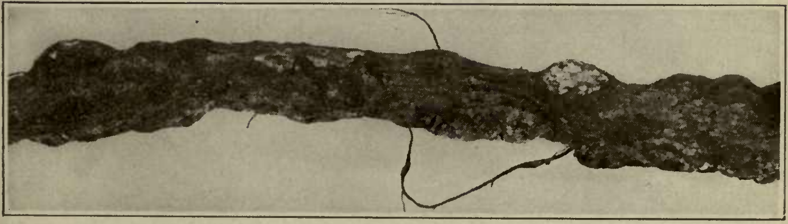


FIG. 66. Apple root, showing knotty growth caused by Woolly Aphid.

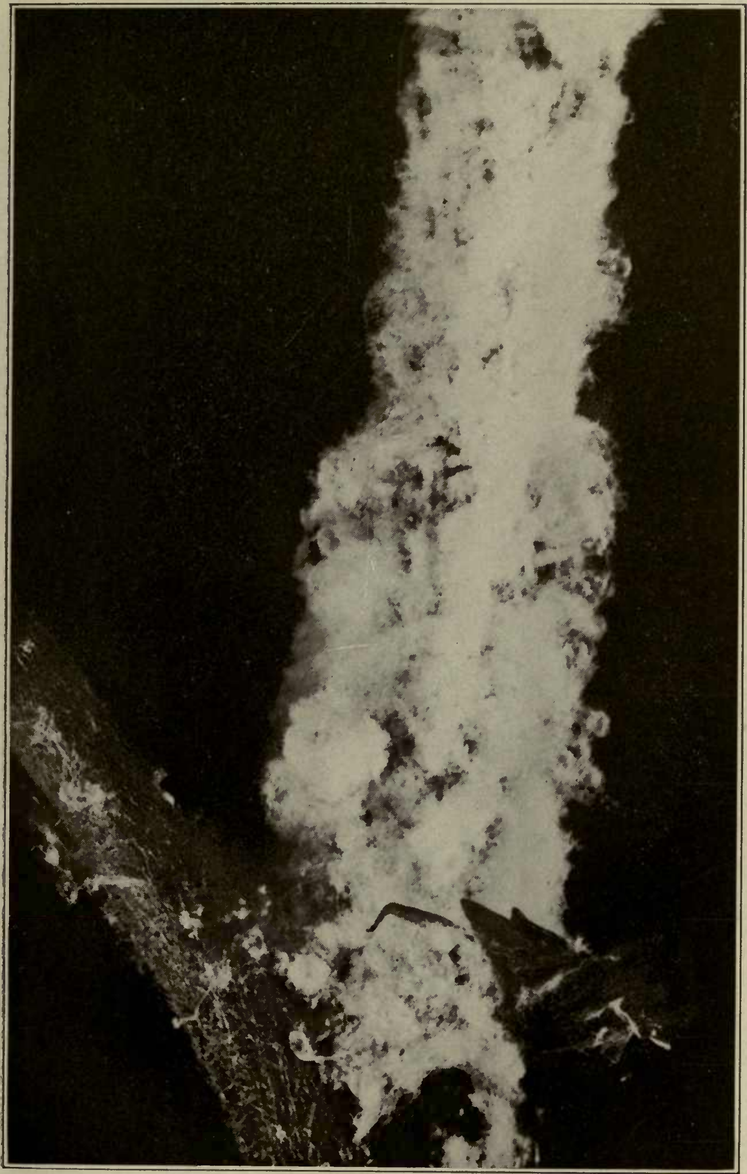


FIG. 67. Nymphs of the Woolly Aphid, *Schizoneura lanigera* on water shoot of mountain ash, *Pyrus americana,*—the immediate progeny of migrants from elm leaf rosette. Photographed at Orono, June 28, 1912. Enlarged.

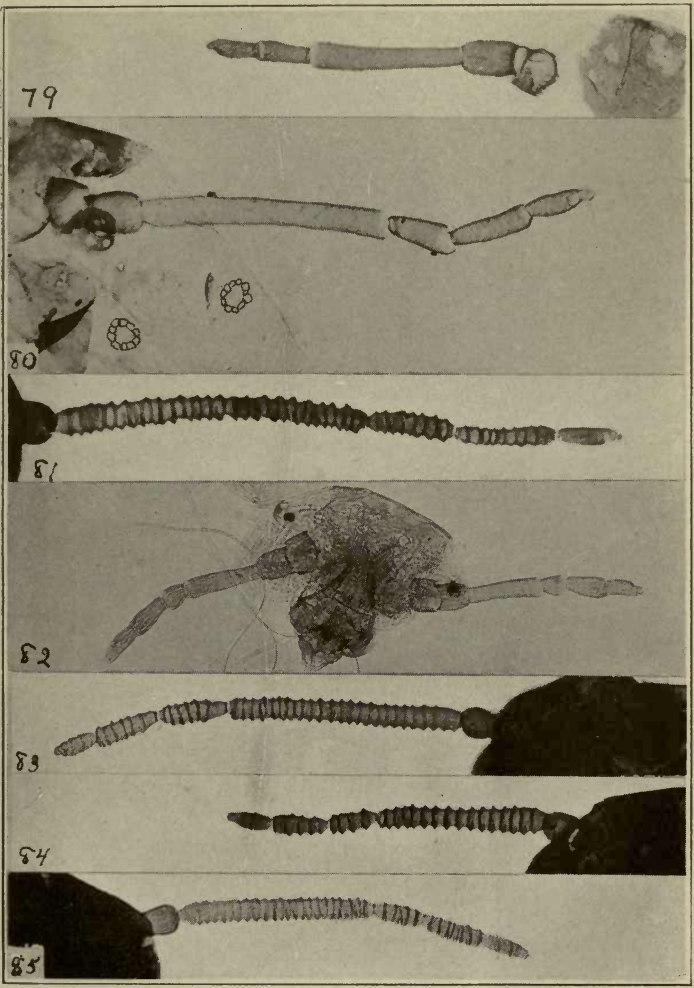


FIG. 68. Nos. 79-85. Antennæ of Woolly Aphid. No. 79—Stem mother from rosette June 5, 1913 (33-13); No. 80—Second generation from rosette June 12, 1913; No. 81—Spring migrant from rosette and progenitor of summer generations on *Pyrus* (57-13); No. 82—Apterous viviparous form on apple bark (98-08); No. 83—Fall migrant from apple (115-06; No. 84—Fall migrant from bred colony on apple; No. 85—Fall migrant from *Crataegus*.

By the Campfire

Courtesy of The Photographic Times

A MANUAL

FOR THE USE OF

LUMBERMEN, WOODSMEN
AND
SPORTSMEN

PROPERTY OF DIVISION OF
FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

PUBLISHED BY THE
KENNEBEC VALLEY PROTECTIVE ASSOCIATION
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BINGHAM, MAINE

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FOREWORD.

The Kennebec Valley Protective Association was organized in the Spring of 1912. The Association is endeavoring to aid in securing wise protective legislation; and in co-operation with the State Department aims to provide their territory with adequate means of fire protection. Also it is striving, by means of publicity material—warning posters and the like—to create a strong sentiment in favor of protection among all who frequent the woods, whether for business or for pleasure.

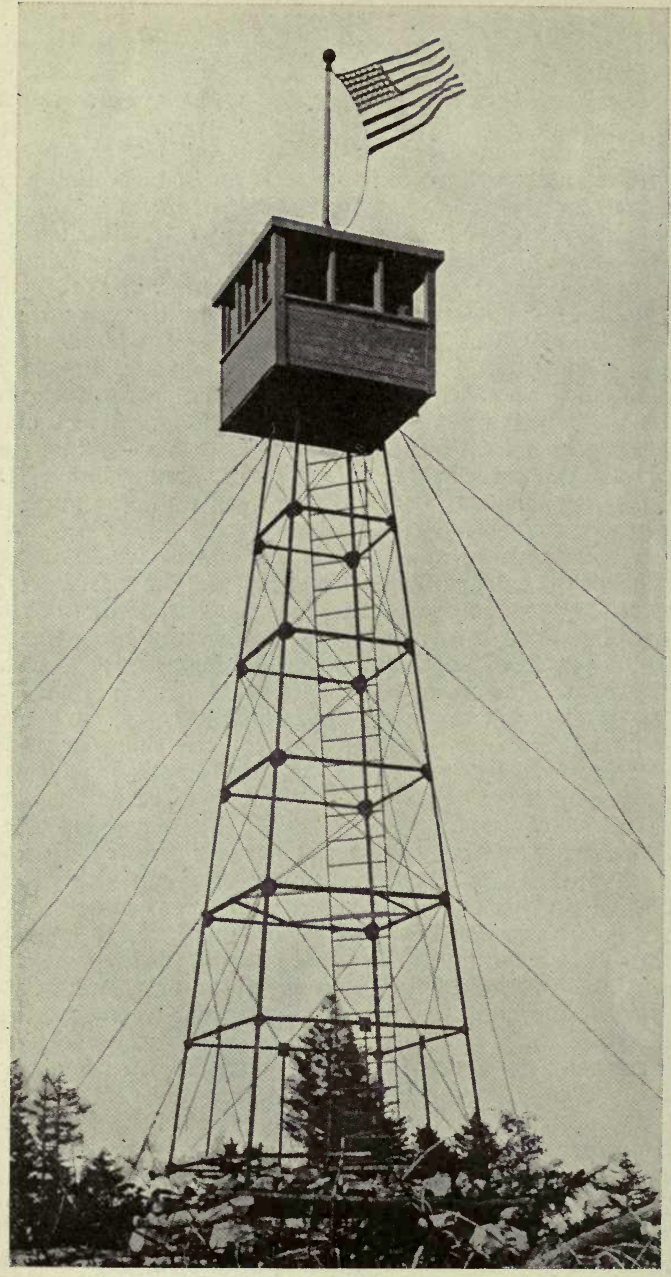
The object of the Association in putting out this little booklet is to spread the gospel of forest fire protection among the thousands whose interests are best served by keeping the woods fresh and green and free from fire-scars. The sportsman must realize the necessity of preserving the woods as a cover for game; those who seek a pleasant Summer sojourn by woodsbound lakes have need to take some thought for the preservation of those charms that lure them each year to the green clad hills; the woodsman must know that each thousand feet of timber burned means labor and wages forever lost to him—a thousand feet of logs that he can never help to cut or yard or haul or drive. Then all should make common cause against that most wanton and destructive enemy of the woodlands—FIRE!

A strict observance of the State Fire Laws would prevent the greater part of the damage from forest fires, and the most important of these laws are given in these pages. The attention of those conducting lumbering operations is invited to the new law regarding the disposal of slash along rights of way of railroads and highways; and also to the article relating to the best method of disposing of such slash.

The greatest crime that can be committed through the agency of a match is the lighting of a destructive forest fire. Consider the case of a building destroyed by fire. Money will replace it. In a year or two we may see another building rise on the same site, easily a better building than the one consumed. Then consider the destruction of a forest by fire. A flaming match, or a lighted cigar or cigarette stub, carelessly tossed among the dry leaves starts the conflagration, which sweeps up a hillside, leaving a bare and blackened ruin hundreds of acres in extent. *Money cannot replace it!* Time may restore this forest to some measure of its former grandeur and value, but scarcely in the life time of a man. Consider this burned area ten years after—or even twenty years—a mass of brush and brambles, with the gaunt and weathered trunks of many fire-killed forest monarchs still standing in disfiguring array.

We trust by the agency of THE GREEN BOOK to impress on its readers the serious consequences of neglecting the simple precautions against forest fires. Let the man in the woods have a care that no spark from his camp fire or match or smoking materials shall kindle and spread destruction through the forests.

For the purpose of adding a greater interest to these pages, certain miscellaneous information of value has been included. While this miscellany has been compiled from the most reliable sources at hand, no responsibility is assumed for its "truth and veracity."



Mountain Lookout Tower

PROPERTY OF DIVISION OF
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THE
MOUNTAIN LOOKOUT STATION

Throughout the State of Maine there are more than half a hundred mountain lookout stations. Recently many of these stations have been equipped with that most modern of appliances—the stanch and symmetrical steel tower with the snug cabin at its top, such as is pictured on the opposite page.

The mountain lookout man has come to be one of the most important factors in the protection of forests from fire. Perched on the mountain top, with unobstructed view on all sides, he can detect the first sign of smoke rising above the tree tops and report by telephone the location of the fire to the chief warden of his district.

Mountain lookout stations are now established in many states of the Union; but the lumbermen of Maine are credited with being the originators of the mountain lookout with telephone connection as a means of promptly detecting forest fires. A number of such stations were established in Maine by landowners and privately maintained, before they were taken over by the Forest Commissioner's department.

LAW

Providing for the Disposition of Inflammable Material Along the Railroads and Highways of the State of Maine.

Section 1. Any person, firm, corporation or agent, cutting any forest growth on property adjacent to the right of way of any railroad or highway within the State, shall leave the growth uncut on the land within fifty feet of the limit of the right of way of a railroad or center of the wrought portion of any plantation, town, city, county or state road; or shall dispose of slash and debris caused by cutting in such a manner that inflammable material shall not remain on the ground within fifty feet of the limit of the right of way of a railroad or center of the wrought portion of any plantation, town, city, county or state road.

Section 2. Slash and debris accumulating by the construction and maintenance of railroads, highways or telegraph or telephone lines, shall be disposed of in such a manner that inflammable material shall not be left on the ground.

Section 3. When any person, firm, corporation or agent shall have failed to dispose of slash and debris as ordered by this act, the Forest Commissioner shall cause such slash and debris to be so disposed of. He shall pay the expense of so disposing of such slash and debris from the funds at his disposal, legally applicable to such purpose; and he or his successor in office shall be entitled to recover double the amount of such expenditures in an action of debt, to be prosecuted by the Attorney General in the Supreme Judicial Court in the County of Kennebec, against the person, firm, corporation or agent whose duty it was to dispose of such slash or debris; and there shall be a lien on the land on which the cutting of the forest growth took place, to secure any judgment recovered in such action, to be enforced by attachment in said action, made within six months after such expenditures were made. The sum recovered and collected in such action shall be returned to and become a part of the fund from which the expenditures were made. Provided, however, that any person, firm, corporation or agent cutting wood or timber during the winter, after November first, shall have until May first following in the Maine forestry district, and until April first in the remainder of the State, to remove such slash and debris. If such slash and debris are destroyed by burning, such burning shall be done with the permission of the Forest Commissioner.

(In effect throughout the State of Maine, July 1, 1915.)

The Kennebec Drive

BURNING BRUSH PILES.

BY HENRY S. GRAVES, FORESTER, U. S. DEPARTMENT OF AGRICULTURE.

An excellent time for burning brush is after the first snow of winter. This is usually a light fall, and the snow does not penetrate the compact piles of brush sufficiently to prevent burning. There is no danger of the fire running on the ground, and the branches of the standing trees are so damp as to prevent injury by the rising flames. If the brush is burned before winter, it should be only during damp weather, when the ground is so wet that fire will not run easily.

When large areas of piled brush are to be burned the work should be organized with care. It should never be undertaken when there is a strong wind, and the best time is in calm weather. If there is any wind, the burning should begin with the piles on the lee side. Several piles may be fired at one time, but they should be some distance apart, with one or more unburnt piles between them. When the first fires have been burned down to coals, the intermediate piles may be ignited. This alternating method of burning the piles prevents the injury to trees and young growth between the piles that might result from the collective volume of heat of adjacent fires. Just as the brush on level ground is burned against the wind, so, on a hillside, the piles near the top are burned first, and the work progresses down the slope.

Whenever large areas of piled brush are to be burned, a sufficient force of men, equipped with fire fighting implements, should always be present to insure that the fire will not get beyond control. In some instances, when brush is piled in the winter during logging and left for later burning, the piles become very wet from the snow and rain and do not dry out till late spring or summer, a time when burning on a large scale is dangerous. If the brush of winter lumbering can not be burned as the logging proceeds, the piles must ordinarily remain unburned till the first snow of the following winter, or till especially wet weather comes in late summer or fall.

The devices used in different localities for starting fires in piled brush are many. Some loggers use a torch of burning wood, as resinous pine; others carry live coals from one pile to another; others use a long-handled torch; others, again, pour a little oil on the brush and start it with a match. The most satisfactory seems to be an ordinary tubular torch with wicking and a ferrule into which a rake handle can be inserted. A good substitute, though a crude one, for the last is a piece of bagging or burlap wound around an iron rod or stick of wood and occasionally saturated with oil.

The cost of burning piled brush in the coniferous forests may vary from one to thirty cents per thousand, according to the manner in which the brush is piled, the condition of the brush, the size of the crew needed to prevent the running of fire, etc. Commonly, it ranges from five to fifteen cents per thousand feet. Where the cost has been higher than this, it has been attributed either to poor work in piling or to inefficient management in the work of burning. The average cost of both piling and burning should range in coniferous forests between ten and fifty cents, and as the lumbermen become more experienced in performing the work the cost will be correspondingly reduced.

In some coniferous forests careful records were kept of the area actually burned over. Where the stand per acre ran from 10,000 to 50,000 feet per acre, the aggregate area burned over by the brush fires was found to be approximately seven per cent. of the total area cut over in the logging operations. Where the brush is burned as the logging proceeds, the percentage of the area burned over is less.—*Reprinted from American Forestry.*

Weights of Materials.

Weight of a cubic foot of iron is about 460 pounds.
Weight of a cubic foot of water is about 62½ pounds.
Weight of a gallon of water is about 8 pounds.
Weight of a gallon of gasoline is about 6 pounds.

Weights of Timber.

Weight of one cord of green spruce pulpwood is about 4,500 pounds.
Weight of one cord of dry spruce pulpwood is about 3,000 pounds.
Weight of one cord of green white-birch is about 6,000 pounds.
Weight of one cord of poplar pulpwood is about 3,200 pounds.
Weight of 1,000 feet of old growth spruce logs, Maine or Holland log rule scale, is about 6,000 pounds.

The weight of green lumber may be reduced from 30 to 50 per cent. or more in seasoning, while the strength of small clear pieces may increase in seasoning up to double the strength when green.

SECTIONS FROM REVISED STATUTES.

Chap. 7, Sec. 55. Whoever by himself, or by his servant, agent or guide, or as the servant, agent or guide of any other person, shall build a camp, cooking or other fire, or use an abandoned camp, cooking or other fire in or adjacent to any woods in this state, shall, before leaving such fire, totally extinguish the same, and upon failure to do so such person shall be punished by a fine of fifty dollars. * * * * * * One-half of any fine imposed and collected under this section shall be paid to the complainant.

Chap. 7, Sec. 56. Camp fires must be totally extinguished before breaking camp, under penalty of not to exceed one month's imprisonment or one hundred dollars fine, or both, as provided by law.

Chap. 28, Sec. 15. Whoever kindles a fire, on land not his own without consent of the owner forfeits ten dollars; if such fire spreads and damages the property of others, he forfeits not less than ten, nor more than five hundred dollars; and, in either case, he shall stand committed until fine and costs are paid, or he shall be imprisoned not more than three years.

Chap. 28, Sec. 16. Whoever with intent to injure another, causes a fire to be kindled on his, or another's land, whereby the property of any other person is injured or destroyed, shall be fined not less than twenty nor more than one thousand dollars, or imprisonment not less than three months, nor more than three years.

Chap 28, Sec. 17. Whoever for a lawful purpose kindles a fire on his own land shall do so at a suitable time and in a careful and prudent manner; and is liable in an action on the case, to any person injured by his failure to comply with this provision.

Chap. 28, Sec. 18. Persons engaged in driving lumber may kindle fires when necessary, but shall use the utmost caution to prevent them from spreading and doing damage, and if they fail so to do, they are subject to all the foregoing liabilities and penalties, as if said privilege had not been allowed.

Chap. 7, Sec. 67. Any person viciously or wantonly tearing down, destroying or defacing this notice, shall on conviction thereof, be punished by a fine of five dollars.

In addition to the above stated fines and penalties all persons are liable in civil suits for all damages caused by fires set by them or by their direction.

Burning Money.

Some men growl about the cost of lumber in building houses nowadays, and then go out into the woods and throw lighted matches and cigar ends among the dry leaves.—*Waterville Sentinel.*

Wireless telegraphy in reporting forest fires has become a regular part of the forest protective service of British Columbia.

RAILROAD FIRES.

Sec. 60, Chap. 7. Rev. Stat. Maine, 1903. Every railroad company whose road passes through waste or forest lands, shall during each year cut and burn off or remove from its right of way all grass, brush or other inflammable material, but under proper care and at times when fires are not liable to spread beyond control.

Sec. 61. All locomotives which shall be run through forest lands, shall be provided with approved and efficient arrangements for preventing the escape of fire and sparks. The forest commissioner may petition the railroad commissioners, setting forth that there is danger of fire to lands within the Maine Forestry District from the operation of locomotives on said railroad; and said commissioners may, after notice and hearing thereon, make such orders and regulations relating to the equipment and operation of locomotives, during times of drought or danger of forest fires, as they deem necessary for the prevention of fires on said lands.

Sec. 62. No railroad company shall permit its employees to deposit fire, live coals or ashes, upon its track in the immediate vicinity of woodlands or lands liable to be overrun by fires, and any railroad company operating a railroad through the Maine Forestry District shall between the first day of May and the tenth day of November following in each year, fasten down or secure screens or other obstructions in the windows of all cars or apartments of cars in which smoking is allowed, to prevent the throwing of burning matches, burning cigars, burning cigarettes or parts thereof from the windows of such cars, and when engineers, conductors or trainmen discover that fences along the right of way or woodlands adjacent to the railroads, are burning or in danger from fire, they shall report the same at their next stopping place which shall be a telegraph office.

RAILROAD PATROL.

The Legislature of 1911 passed a bill compelling railroads to maintain proper patrol during dry and dangerous seasons, the bill being entitled "An Act for the better protection of Forests from Fire," and is as follows:

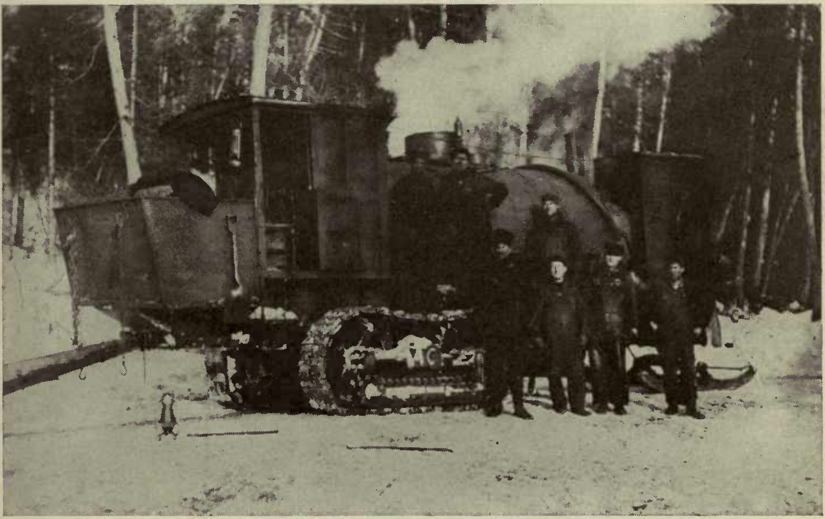
Section 1. It shall be the duty of the forest commissioner whenever, in his judgment, the woodlands along the railroads transversing the wild lands of the state, over which said commissioner has jurisdiction, are in a dry and dangerous condition, to maintain a competent and efficient fire patrol along the right of way or lands of said railroads.

Section 2. The forest commissioner shall keep or cause to be kept, an account of the cost of maintaining such fire patrol along the line of such railroad, including therein the wages and expenses of the employees engaged in maintaining such fire patrol, and the total cost thereof shall be paid to the forest commissioner, by the railroad company along whose land or right of way such patrol is maintained, such payment to be made monthly or on the presentation of the bills therefor. All such funds received by said commissioner shall be credited to the fund for the protection of the forests against fire from which it was drawn.

Section 3. All fires started upon the right of way of any railroad or lands adjacent thereto shall be immediately reported to the commissioner upon blanks to be furnished by him, by the patrolman within whose limits the fire originated, setting forth the origin of such fire, the quantity and quality of the land burned over, and, if the fire was started by a locomotive, he shall give the number thereof.

Section 4. No railroad employee shall build a fire to burn rubbish along its right of way through forest lands when forbidden to do so by the forest commissioner, or his wardens.

Section 5. Nothing in this act shall be construed as releasing any railroad company from any damage caused by fires set by their locomotives or employees.



Steam Loghauler

Some Observations on Hunting, from the Writings of Dan Beard.

To me, the greatest crime committed with firearms is the shooting of a fellow human being in mistake for game.

One of the reasons that firearms are of use is that they are dangerous. Let your bearing toward your gun be one of constant watchfulness. Let your enjoyment of hunting lie in the pleasure of studying the habits of wild animals, and in doing well a man's part in the dangers and hardships of the wilderness hunt. Let your desire be to kill what game you do, as a man, rather than to kill a lot, as a butcher.

In this way you will grow younger as you grow older, and the freshness of the fields, and the dignity of the mountains, and the laughter of the clear streams, will enter into you and be a part of you.—*Selected.*

A Few Dont's for Hunters.

Don't pass a loaded gun for inspection to a brother hunter, or anyone else for that matter.

Don't leave a loaded gun around the house or camp or anywhere else.

Don't—whether it is loaded or not—lay hold of a gun by the muzzle and pull it toward you, from a canoe or a wagon.

Don't climb over a fence with a loaded gun in your hands.

Don't put off the cleaning of your gun till to-morrow.

Don't think you can do accurate shooting with a dirty gun.

Don't "walk up" on any wounded game without having a cartridge in the chamber of your rifle, ready for any surprise.

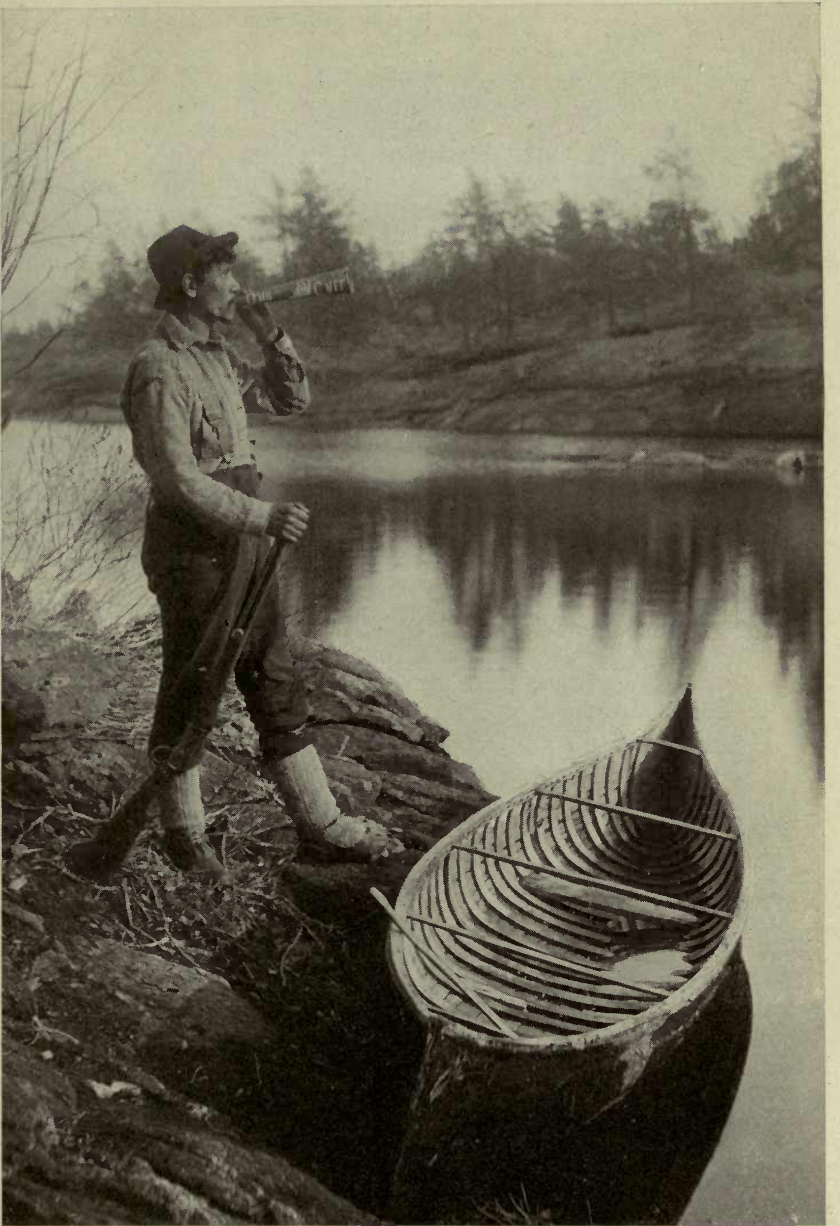
Don't by any chance set the woods afire.

Tea by the Open Fire.

From the faucets of the fountain,
And the bottles of the bar,
I've tried many fancy gargles,
Most as many as there are,
But the drink that's first and foremost,
If you put it up to me,
Is the scalding can of ashes,
Swamp juice, soot—and tea.

—*C. L. Gilman, Outing.*

Experts agree that any powder residue commences to work on the barrel of your rifle the instant the shot is fired. The quicker the gun is cleaned the less damage results.



Calling Moose

Courtesy of The Photographic Times

Concerning Fire Risks on Timberlands.

The risk from fire to timberland properties has in some ways greatly diminished, due to government and state fire wardens and patrols, and the general better education of the public as well as the keen desire natural to the lumber companies for protection against such a fearful plague.

Upon the other hand, because of the railroads pushing back into the wilderness, spreading sparks in territory never before traversed by a locomotive; because of the almost universal use now of a type of cigarette which does not go out, but consumes itself to the last ash after it has been thrown aside by the thoughtless smoker; because of the increasing trend towards camping life and one thing and another, the fire hazard has not only increased, in some ways, but the area of such risks has been enlarged.—*Forest Quarterly.*

Taper of Logs.

Rough logs taper more than clear smooth logs. Average taper does not differ greatly in different localities or with different species. As a result of measuring the average taper is found to be about one inch in eight feet.

A charge of shot will fall 8 inches in 40 yards.

To dry shoes over night, heat a quart or so of pebbles and put a pint in each shoe.

Some of the new high-power smokeless cartridges have a breech pressure of 40,000 pounds to the square inch.

Wild ducks flying travel over 100 feet in a second. If fifty yards away he will travel 15 feet in the time it takes for shot to reach him.

It is much cheaper to prevent forest fires than to extinguish them. Five minutes' work at a fire at its beginning is worth days of labor put in after it has gained great headway.

The common surgeon's adhesive plaster makes a good emergency mend for small cuts or punctures in a canoe. Just stick it on and iron it fast with something hot. A stone heated in the fireplace will do the trick.

Good Hunting

"When the Man With the Gun Takes the Field."

"The game is not the only thing that suffers when the man with the gun takes the field. Men, too, are numbered among the victims," remarks the editor of a sporting magazine.

Statistics are given every year, but evidently that does not lessen the evil. Not till the hunter can be persuaded to make absolutely sure that the object he is firing at is not a human being, will men cease to go down before the sporting rifle. The chances the man with the gun will take—or rather, make the other fellow take, are something astonishing. A few years ago the papers recorded how a man was shot even for a *rabbit!* The hunter sighted the brown cap of a man sitting in the tall grass. He saw it move, and he "let 'im have it."

Here is another instance recorded by the papers: A hunter let fly with a load of buckshot at six men passing along a road at twilight. Four of the men went down together!

Let every "man with the gun" make a double bound, copper riveted, indestructable resolution that he will hold his fire till he is absolutely sure it is game he is shooting at. It may cost him sometimes the chance to kill game, but what is that compared to eliminating the chances of wounding or killing his fellowmen.

Howard's Method of Reviving the Drowned.

Rule 1.—Upon the nearest dry spot expose the patient to a free current of air; rip the clothing away from the waist and give a stinging slap upon the pit of the stomach. If this fails to arouse the patient, proceed to force and drain away the water which has entered the stomach, according to Rule 2.

Rule 2.—Turn the patient upon his face, the pit of the stomach being raised, upon a folded garment, above the level of the mouth. For a moment or two make a steady pressure upon the back of the stomach and chest, and repeat it once or twice until fluid ceases to flow from the mouth.

Rule 3.—Quickly turn the patient upon his back, with a roll of clothing beneath him so as to raise the lower part of the breast-bone higher than the rest of the body. Kneel beside or astride of the patient, and so place your hands upon either side of the pit of the stomach, upon the front part of the lower ribs, that the fingers fall naturally in the spaces between them and point toward the ground. Now grasping the waist, and using your knees as a pivot, throw your whole weight forward, as if you wished to force the contents of the chest and stomach out of the mouth. Steadily increase the pressure while you count one, two, three, then *suddenly* let go, with a final push which springs you into an erect kneeling position. Remain erect upon your knees while you count one, two, then throw your weight forward and proceed again as before. Repeat the process at first about five times a minute, increasing the rate gradually to about fifteen times a minute, and continue it with the regularity of the natural breathing which you are imitating. If another person be present let him with the left hand hold the tip of the tongue out of the left side of the mouth with the corner of a pocket handkerchief, while with the right hand he grasps both wrists and pins them to the ground above the patient's head.

After-treatment.—When breathing first returns, dash violently a little cold water in the face. As soon as breathing has been perfectly restored, strip and dry the patient rapidly and completely and wrap him in blankets only. Give a hot stimulant, a teaspoonful every five minutes the first half hour and a tablespoonful every fifteen minutes for an hour after that. If the limbs are cold, apply friction. Allow abundance of fresh air, and let the patient have perfect rest.

Avoid delay. A moment lost may be a life lost. Waste no time in hunting for shelter. Fresh outdoor air is best for the patient. Do not attempt to give stimulants before the patient is well able to swallow. Do not give up too soon. At any time within an hour you may be on the very threshold of success, though no sign of it be visible.

Then here is another and perhaps easier rule that may be substituted for Rule 3. After following out Rule 1 and Rule 2 as given above, try to restore breathing by this method:

After the tongue has been drawn forward so as not to hinder the free passage of air through the mouth, kneel behind the patient's head, grasp him by the forearms halfway between elbows and wrists and draw his arms up and over his head rather quickly but steadily, until his hands touch the ground behind the head. Hold them there while you count two. This motion draws the ribs up, extending the chest, and the air enters. Then carry the arms back again until they rest against the sides of the chest, the forearms a little on top of the chest. Then press the forearms firmly downward on the chest for two counts. This depresses the ribs and forces air out.

Repeat these motions at the rate of fifteen or sixteen times a minute—force the forearms up over the head and then back again and a gentle pressure on the chest.

The "Don'ts."

(Compiled by the United States Forest Service.)

1. **Don't** throw your match away until you are sure it is out.
2. **Don't** drop cigarette or cigar butts until the glow is extinguished.
3. **Don't** knock out your pipe ashes while hot or where they will fall into dry leaves or other inflammable material.
4. **Don't** build a camp fire any larger than is absolutely necessary.
5. **Don't** build a fire against a tree, a log, or a stump, or anywhere but on bare soil.
6. **Don't** leave a fire until you are sure it is out; if necessary smother it with earth or water.
7. **Don't** burn brush or refuse in or near the woods if there is any chance that the fire may spread beyond your control, or that the wind may carry sparks where they would start a new fire.
8. **Don't** be any more careless with fire in the woods than you are with fire in your own home.
9. **Don't** be idle when you discover a fire in the woods; if you can't put it out yourself, get help. Where a forest guard, ranger, or state fire warden can be reached, call him up on the nearest telephone you can find.
10. **Don't** forget that human thoughtlessness and negligence are the causes of more than half of the forest fires in this country, and that the smallest spark may start a conflagration that will result in loss of life and destruction of timber and young growth valuable not only for lumber but for their influence in helping to prevent flood, erosion, and drought.

Does It Pay to Plant Trees?

In the spring of 1871 three acres of practically worthless land in Westmoreland, New Hampshire, was planted with trees at seven foot intervals. In 1911 this three acre tract of planted trees was sold for an even $1,000.

Big Game

Forest Fire Figures for the United States for One Year.

A close estimate for 1914.

Total area burned...............	7,000,000 acres
Total property loss..............	$20,000,000
Total number of fires reported....	14,000

Of these 4 per cent. were caused by lightning, 30 per cent. from causes unknown, and 66 per cent., or considerable more than half, from all other causes including campers, railroads, brush burning, incendiaries, sawmills and the like, all of which are preventable.

To Measure Heights of Standing Trees by the "Shadow Method."

Set a straight pole in the ground in the vicinity of the tree you wish to measure. Multiply the length of the shadow of the tree by the length of the pole, and divide the product by the length of the shadow of the pole. The result will be the height of the tree.

The old idea was that a gun was effective as long as it would hold together; but that was before the day of smokeless powder. After experiments by army officers it has been established that with perfect care a rifle will stand about 8,000 rounds before it begins to show defects in the barrel.

A FEW INSTRUCTIONS IN FIRST AID TO THE INJURED.

First aid instructions are intended only for use in case the doctor cannot be immediately secured to attend the patient, as often happens in the woods. Their object principally is to make the injured one as comfortable as possible without delay. Act quickly, but quietly. Make the patient sit down or lie down. See an injury clearly before treating it. Do not remove more clothing than is necessary to examine. Always rip or cut clothing around an injury; do not pull clothing off. Practice absolute cleanliness. Do not touch a raw wound with the fingers or anything else that is not absolutely clean. Give alcoholic stimulants sparingly. Generally hot drinks will suffice.

Broken Bones.

In cases of fracture little can be done except to prepare the patient for the journey to his headquarters or home, or to the hospital. If it happens to be a broken limb the main object to strive for is to prevent the injured member from being moved or rolled about during the journey. Movement of the fractured ends of the bone results in damage to the adjoining nerves and muscles, creating more inflammation. Strips of wood may be placed on each side of the broken limb and bound in place lightly but firmly with bandages; but never bind directly over the fracture. This binding will keep the bone in its natural position and prevent movement at the break. In case of a broken arm, the forearm should be hung in a wide sling from the neck and then bound lightly to the body. If it is a broken leg, after the patient has been laid on stretcher or cot for transportation, in addition to having the limb bound with strips of wood, as already mentioned, it is well to secure the leg so that it cannot rock or roll about during the journey. This can be done by laying rolls of clothing on each side of the limb, or by rolling up a blanket from each end, and then laying the leg between the rolls as in a trough.

Wounds.

In the treatment of wounds it is well to have a care for even the little cuts, punctures and scratches that are of common occurrence and considered of no consequence. It is the natural tendency of healthy flesh to heal a slight wound promptly. Nevertheless, while the most frightful wounds have occasionally been known to heal perfectly almost without attention, just the slightest cut or a mere pin prick has some times resulted in great suffering and death. Small wounds should be kept clean and treated with mild antiseptic solutions, and their surfaces protected by clean wrappings. Wounds of a serious nature require the services of the doctor or surgeon; but if there is delay in securing such services there are certain first aid rules that may be applied. Keep everything out of a serious wound until the doctor comes. Remove or cut away the clothing around it, and try to stop serious loss of blood by drawing the edges of the wound together with the fingers or by firm bandaging. Drawing the lips of the wound together should decrease the flow of blood. In case blood still flows freely, you may have to make a compress by wrapping a piece of wood or a smooth flat stone in clean cloth and applying it with considerable pressure over the wound. This pressure may be applied by hand or a very loose narrow bandage may be put around the part, loose enough so that a small stick or pencil may be twisted in the bandage to tighten it. Sometimes if the wound is on the extremities a bandage that can be twisted tight in the above manner is arranged between the wound (on the arm or the leg) and the body.

But if a bandage on an arm or leg has to be twisted very tight to stop the flow of blood, as might be the case if an artery has been opened, the entire circulation in that limb is stopped. In that case it is necessary to loosen up this bandage once every hour. If blood still flows from the wound exert some pressure directly on the compress with the hand for a few moments until circulation has been somewhat restored in the limb, then tighten the bandage again by twisting. Above all things, keep the injured member absolutely quiet. In case of bleeding from a limb, benefit will be derived from keeping the limb elevated, since naturally the flow of blood will be diminished by such a position. In case of a wound having more than one opening, such as a bullet hole through an arm or a leg, it is necessary in bandaging to put a compress over each hole or wound. If any washing away of blood from the wound seems necessary dilute in the water some standard antiseptic solution. An antiseptic of some sort should form a part of every emergency or medicine kit. A solution of carbolic acid may be used, taking one part acid to twenty-five parts water. Then shake well before using.

Burns.

Air should be kept from burns. Dress the injured part with vaseline, cold cream, olive oil or any fat that is not rancid. Soft cloths spread with any of these ointments can be laid on the burn for a dressing. Do not try to pick the blisters formed on the surface of the burn. If there is much pain in the burned surface, it can be relieved by dissolving a tablespoonful of baking soda in a pint of water and applying this by means of soft cloths. These cloths should be wet frequently in order to prevent their drying and sticking to the burned surface.

Frost Bite.

Do not bring a person with frost bite or frozen limbs near the fire. Rub with the hands or with flannels. Give stimulants in small quantities, hot tea or coffee. A frozen limb may be rubbed with snow, or with cloths wet with cold water. Or the limb may be put in cold water.

Poison.

In case of poisoning the first thing to do is to empty the stomach. To do this give a cup of warm water in which a teaspoonful of ground dry mustard has been mixed. If this does not produce vomiting, follow with a second cupful of the mixture, then push the forefinger as far down the throat as possible and keep it there until vomiting is produced. The forefinger is one of the best of emetics. If mustard is lacking take a teaspoonful of salt in the warm water. After the emetic has to some extent relieved the stomach of the poison, make the patient drink large quantities of water, or better still, of milk. The white of an egg, or a little flour stirred in the water will be good. The purpose of taking this large quantity of liquid is to dilute any of the poison that may be left in the stomach. If the poisoning results from an acid a little baking soda diluted in the water will help neutralize the acid.

Rules for Care With Fire in the Woods.

If every person would strictly observe the following rules, as formulated by *American Forestry*, the forest fire risk would practically be wiped out:

Rule 1.—Be sure your match is out before you throw it away.

Rule 2.—Knock out your pipe ashes or throw your cigar or cigarette stump where there is nothing to catch fire.

Rule 3.—Don't build a camp fire any larger than is absolutely necessary. Never leave it, even for a short time, without putting it OUT with water or earth.

Rule 4.—Don't build a camp fire against a tree or log. Build a small one where you can scrape away the needles, leaves or grass from all sides of it.

Rule 5.—Don't build bonfires. The wind may rise at any time and start a fire which you cannot control.

Rule 6.—If you discover a fire, put it out if possible; if you can't, inform the nearest forest ranger or fire warden, as quickly as you possibly can.

Prevailing Standard Weights per Bushel.

Wheat	60	pounds	Potatoes	60	pounds
Rye	56	"	Onions	52	"
Corn (shelled)	56	"	Wheat bran	20	"
Corn (on cob)	70	"	Rock salt	70	"
Barley	48	"	Fine salt	60	"
Oats	32	"	Corn meal	50	"
Peas	60	"	Clover seed	60	"
Beans	60	"	Timothy seed	45	"
Buckwheat	48	"	Turnips	50	"

The word forest is derived from the Latin *foris,* meaning out-of-doors. The original meaning of the word forestry was the art of hunting, and had little to do with the care of the forests.

Extracts from the Fisherman's Classic, Izaak Walton's "Complete Angler," Published in London in 1653:

For the sight of any shadow amazes the fish and spoils your sport, of which you must take good care.

For you are to know that a dead worm is but a dead bait, and like to catch nothing, compared to a lively, quick, stirring worm.

For a companion that is cheerful and free from swearing and scurrilous discourse, is worth gold. I love such mirth as does not make friends ashamed to look upon one another next morning.

For angling may be said to be so like the mathematics that it can never be fully learned; at least not so fully but that there will still be more new experiments left for the trial of other men that succeed us.

As inward love breeds outward talk,
The hound some praise, and some the hawk;
Some, better pleased with private sport,
Use tennis, some a mistress court.
But these delights I never wish,
Nor envy, while I freely fish.
—*Angler's Song.*

For Fishermen.

Don't use too big flies or hooks. A big fish can take a little hook, but a large hook is too big for the little ones.

Swift's famous description of the art of fishing: "A stick and a string, with a fly on one end and a fool at the other."

Fish that are killed immediately, as soon as caught, keep better than those that are allowed to flop about and die by inches. To kill a fish give it a sharp blow between the eyes with a stick or the handle of a knife.

If your line is in a knot,
  Patience will untie it;
Patience does most everything,
  If you will but try it.
—*Selected.*

Winter Fishing

Courtesy of The Photographic Times

To Keep Angle Worms.

If you are going to keep angle worms for some time, better than keeping them in a can is to keep them in a jar; and at all times better than dirt to keep them in is damp green moss. With a small portion of the white of a hard boiled egg, or a teaspoonful of cream, it is said you may feed and fatten them.

Always test your line, leader and snells before you start fishing. This practice may sometime save you a big one.

Always carry along a small file to sharpen your hooks. If you will examine them occasionally, you will sometimes find them very dull.

Keep your revolving fish spoons bright. If you feel that your spoon is too small for the waters you are fishing, try tying a red or any bright colored rag ahead of it.

Good Fishing

Courtesy of The Photographic Times

The Woods Flapjack.

The "standard woods flapjack" is said to be made up as follows: 1 quart flour, 1 teaspoonful salt, 2 teaspoonfuls sugar or 4 of molasses, 2 teaspoonfuls baking powder, 2 tablespoonfuls grease well rubbed in the dry flour. Mix to medium batter.

A writer remarks that the woods flapjack is not fit food for infants or invalids, or those who lead the steam-heated life, but that it is well calculated to keep up steam under the boiler of a man who is toiling hard and traveling far in the open air.

An "Army Bread" That Wears Well.

Something durable in the bread line, something which will wear well in the pocket and feel substantial between the jaws is always in demand where there is a "base camp" as the center of daily hunts or hikes.

A quart of white flour, half a teaspoonful of salt, two teaspoonfuls baking powder, two tablespoonfuls molasses and one teaspoonful ginger, mixed to a heavy slush with water, baked thoroughly and pried loose, then turned over and baked some more, makes a great noon snack staple. Unlike the biscuit or the flapjack, it tastes well cold, it will stand rough handling, and it will keep fresh for a week or more. It cannot, however, be recommended for folks with brittle teeth.—*Outing.*

"Dope."

Place a pound of diced salt pork in the fry pan with water and boil one minute. Pour off the water and fry the pork until nearly brown. Remove the pieces and rub into the hot fat three dessertspoonfuls of flour and a little pepper, allowing the flour to cook in the fat without browning. When perfectly smooth add one quart of water in which twelve dessertspoonfuls of evaporated milk have been dissolved. Slowly bring to a boil, stirring constantly; add the pork scrap and serve. This sauce is a palatable way of serving pork, is a good substitute for butter, and is particularly good with griddle cakes.—*Camp Cookery, Kephart.*

North Woods Bannock.

To make a batch of Bannock, mix an ordinary biscuit dough, but doubling the quantity of shortening, and making the mixture just thin enough to pour. Then heat some lard in the frying pan, and pour in the material. Give moderate heat until it rises—then brown. Slide out on a plate, heat more lard in frying pan, and then brown the other side. It takes about 25 minutes to bake.

Porcupine's Liver.

If you want a delicacy try porcupine's liver. The liver is easily removed by making a cut just under the neck into which the hand is thrust and the liver pulled out. It may be fried with bacon, or baked slowly with slices of bacon.

What better place to post a fire warning can be thought of than on a box of matches. A Canadian firm of match manufacturers is placing an imprint in three colors on each box of their matches, requesting the user to exercise care when throwing aside a burned match that no flame or live coal remains.

Picking Out a "Jam" on the Kennebec

A PAGE OF FIRE WARNINGS FROM OTHER STATES.

FOREST FIRES

YOUR HELP IS ABSOLUTELY NECESSARY TO PREVENT WOODLAND FIRES.
READ THESE LAWS, OBEY THEM AND HELP ENFORCE THEM IN YOUR TOWN.
GET PERMIT FROM WARDEN BEFORE KINDLING FIRES IN SPRING OR FALL.
DO NOT THROW DOWN LIGHTED MATCHES, CIGARS OR OTHER MATERIALS.
NOTIFY THE NEAREST WARDEN IN CASE OF FIRE AND GET BUSY YOURSELF.

EXTRACTS—CONNECTICUT FOREST FIRE LAWS.

1. Kindling a fire upon public or private land without permission of the owner is subject to fine and imprisonment. See 1220 Gen. Stats.

2. Kindling a fire in woodland without clearing space of 20 feet around it is punishable by fine and imprisonment. Fires must be extinguished before leaving. Chap. 43 Pub. Acts 1907.

3. Kindling a fire in the open air which damages property of another is subject to fine and imprisonment. Chap. 128, Sec. 3, Public Acts 1909. Persons setting fires which runs on land of another are liable to the owner for all damages caused. Sec. 1096 Gen. Stats.

4. Kindling a fire by throwing down a lighted match, cigar or other burning substance is punishable by $500. fine or imprisonment six months or both. Sec. 1220 Gen. Stats.

5. Permits required for kindling fires March 15th to June 1: Sept. 15 to Nov. 15. Written permission from a local warden is required for kindling a fire in the open air except in a ploughed field, garden or public highway not less than 200 feet from woodland, brushland or land covered by dry grass or other inflammable material. (This law does not apply to kindling fires in cities, boroughs, organized fire districts, and on land controlled by railroad company.) Violation of this law is punishable by $200. fine or six months imprisonment or both. Chap. 124, Sec. 2, Public Acts 1911.

6. Any fire warden may arrest without warrant persons taken in the act of violating any laws for the protection of forest and timberlands. Chap. 238, Sec. 4, Public Acts 1905.

7. The law provides a penalty of $10. for injuring this notice. Chap. 238, Sec. 10, Public Acts 1905.

Posted by order of
WALTER O. FILLEY
State Forest Fire Warden.

FOREST FIRES
MENACE PROSPERITY

A Little Care on YOUR PART May Result in the Saving of THOUSANDS of DOLLARS to CITIZENS of OREGON

Do You Realize that Oregon Timber Pays About One-third of the State's Taxes?

That Oregon's Forests Distribute More Wealth in the State than Grain, Fruit, Vegetables and Fish Combined?

GOOD CITIZENSHIP DEMANDS OBSERVANCE OF THE FOREST FIRE LAWS

OREGON FOREST FIRE ASSOCIATION
718-718 Yeon Building, Portland, Oregon

SAVE IDAHO
MILLIONS OF DOLLARS YEARLY
BY BEING CAREFUL IN THE USE OF FIRE

FOREST FIRES MEAN—
- DANGER TO LIVES AND HOMES OF SETTLERS
- LABOR TURNED AWAY EMPTY-HANDED
- REDUCED MARKET FOR OUR CROPS
- HEAVIER TAXES ON OTHER PROPERTY
- STREAM FLOW DISTURBED

For every dollar lost by timber owners, the **Community Loses** Five times as much in **WAGES AND MARKET FOR SUPPLIES**

GOOD CITIZENSHIP FORBIDS— THE LAW PUNISHES—

Tossing away burning matches or tobacco;
Building camp fires in leaves, rotten wood or against logs, where they may spread or be impossible to extinguish;
Leaving any camp fire before it is out;
Burning brush or slashings in dry season without permit;
Using spark-emitting engines in the dry season;
Refusing to fight fire when summoned by a fire warden.

CARE WITH SMALL FIRES, BY PREVENTING LARGE ONES, MEANS PROSPERITY INSURANCE

Violation of these rules may cause injury and distress beyond calculation. Help Enforce Them! Put out any fire you find if you can. If you cannot, notify a fire warden, some other public officer or the land owner.

For the law send to—

STATE LAND COMMISSIONER
BOISE, IDAHO

FOREST FIRES!
WARNING

It is Unlawful and Punishable by Fine and Imprisonment

First--To set and leave any fire that may spread to adjacent timber or other property.

Second--To burn slashings, choppings, and the like, from June 1st to October 1st, without a permit issued by a Fire Warden or Forest Ranger.

Third--To operate spark-emitting locomotives, engines or boilers without using safe and effective spark arresters.

Fourth--To deface, destroy, or remove this notice.

Campers, hunters, fishermen and others are warned against building campfires in moss, rotten wood or against old logs, where the fire may smoulder and finally burst into flame and spread to adjoining timber or other property. Never leave your fire until you are sure it is out.

Help Protect the Forests from Fire

We ask your co-operation and assistance in protecting timber and other property from fire. Use the same care with fire in forest regions that you would use in your own home or in a city. Put out a fire if you can. If you cannot, notify the nearest Fire Warden or Ranger.

Approved by the
State Board of Forest Commissioners

E. W. FERRIS
STATE FORESTER AND FIRE WARDEN

FRANK M. LAMBORN PUBLIC PRINTER, OLYMPIA

MONTHLY WAGES TABLE

26 WORKING DAYS IN A MONTH

No. Days	$20	$21	$22	$23	$24	$25	$26	$27	$28	$29	$30	$31	$32	$33	$34	$35	$36	$37	$38	$39	$40
1	.77	.80	.85	.89	.92	.96	1.00	1.04	1.07	1.12	1.15	1.20	1.23	1.27	1.30	1.35	1.38	1.42	1.46	1.50	1.50
2	1.54	1.60	1.70	1.77	1.85	1.92	2.00	2.08	2.15	2.25	2.30	2.40	2.46	2.54	2.60	2.70	2.77	2.80	2.90	3.00	3.08
3	2.31	2.40	2.55	2.65	2.77	2.88	3.00	3.10	3.24	3.35	3.45	3.57	3.70	3.81	3.90	4.05	4.15	4.25	4.36	4.50	4.62
4	3.08	3.20	3.38	3.54	3.70	3.85	4.00	4.15	4.29	4.47	4.62	4.76	4.93	5.07	5.20	5.40	5.53	5.70	5.82	6.00	6.16
5	3.85	4.00	4.23	4.43	4.62	4.80	5.00	5.20	5.35	5.60	5.77	6.00	6.16	6.35	6.50	6.70	6.90	7.12	7.28	7.50	7.70
6	4.62	4.80	5.10	5.30	5.55	5.75	6.00	6.24	6.42	6.72	6.80	7.19	7.40	7.60	7.80	8.05	8.28	8.55	8.75	9.00	9.24
7	5.38	5.60	5.95	6.20	6.45	6.70	7.00	7.27	7.50	7.84	7.95	8.38	8.63	8.87	9.10	9.40	9.65	9.97	10.20	10.50	10.75
8	6.15	6.40	6.75	7.08	7.38	7.68	8.00	8.30	8.57	8.96	9.10	9.58	9.85	10.14	10.40	10.75	11.05	11.40	11.65	12.00	12.32
9	6.92	7.20	7.60	7.95	8.30	8.64	9.00	9.35	9.63	10.08	10.25	10.77	11.08	11.40	11.70	12.05	12.50	12.83	13.10	13.50	13.85
10	7.69	8.00	8.45	8.85	9.23	9.60	10.00	10.40	10.70	11.20	11.45	11.96	12.30	12.67	13.00	13.40	13.88	14.25	14.55	15.00	15.35
11	8.46	8.80	9.30	9.73	10.15	10.56	11.00	11.44	11.80	12.32	12.60	13.15	13.50	13.93	14.30	14.75	15.26	15.65	16.00	16.50	16.90
12	9.23	9.60	10.15	10.62	11.08	11.52	12.00	12.48	12.90	13.45	13.80	14.35	14.75	15.20	15.65	16.15	16.65	17.10	17.55	18.00	18.45
13	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	15.50	16.00	16.50	17.00	17.50	18.00	18.50	19.00	19.50	20.00
14	10.77	11.20	11.85	12.40	12.92	13.46	14.00	14.55	15.05	15.70	16.15	16.70	17.23	17.76	18.30	18.85	19.40	19.92	20.46	21.00	21.54
15	11.54	12.00	12.70	13.30	13.75	14.42	15.00	15.60	16.12	16.82	17.30	17.90	18.47	19.00	19.60	20.20	20.78	21.35	21.92	22.50	23.05
16	12.31	12.80	13.50	14.18	14.67	15.48	16.00	16.64	17.20	17.95	18.45	19.10	19.70	20.27	20.90	21.55	22.15	22.77	23.38	24.00	24.60
17	13.08	13.60	14.35	15.05	15.60	16.45	17.00	17.68	18.25	19.07	19.60	20.30	20.93	21.54	22.20	22.90	23.53	24.20	24.85	25.50	26.13
18	13.85	14.40	15.20	15.95	16.52	17.40	18.00	18.72	19.32	20.20	20.80	21.50	22.15	22.80	23.50	24.25	24.90	25.60	26.30	27.00	27.65
19	14.62	15.20	16.00	16.80	17.45	18.35	19.00	19.75	20.40	21.32	21.95	22.70	23.38	24.05	24.80	25.60	26.30	27.02	27.75	28.50	29.20
20	15.38	16.00	16.85	17.70	18.37	19.30	20.00	20.80	21.47	22.45	23.10	23.90	24.60	25.32	26.15	26.95	27.70	28.65	29.20	30.00	30.75
21	16.15	16.80	17.75	18.60	19.30	20.26	21.00	21.84	22.55	23.55	24.25	25.10	25.83	26.60	27.40	28.30	29.08	30.10	30.75	31.50	32.25
22	16.92	17.65	18.60	19.50	20.22	21.22	22.00	22.88	23.62	24.65	25.40	26.30	27.05	27.87	28.70	29.65	30.45	31.55	32.21	33.00	33.80
23	17.69	18.45	19.45	20.38	21.15	22.18	23.00	23.90	24.70	25.77	26.60	27.50	28.28	29.14	30.00	31.00	31.83	32.97	33.67	34.50	35.35
24	18.46	19.25	20.30	21.25	22.07	23.15	24.00	24.96	25.80	26.90	27.75	28.70	29.50	30.41	31.35	32.35	33.20	34.40	35.13	36.00	36.90
25	19.23	20.10	21.15	22.10	23.10	24.10	25.00	25.98	26.95	27.95	28.85	29.90	30.75	31.70	32.65	33.70	34.60	35.55	36.36	37.50	38.45

EXAMPLE: To find the amount of wage for 5 days at $30 per month of 26 days. Follow down the No. of Days column until you come to 5, then follow across to the column headed $30, and the amount given there ($5.77) is the sum required.

Breck's Rule for Bulk Provisions for a Party of Four for Two Weeks' Trip.

Flour	30	pounds
Rice	5	“
Meats (pork, bacon, ham)	20	“
Lard	5	“
Sugar	10	“
Tea	2	“
Coffee	3	“
Beans	8	“
Evaporated milk	10	cans
Butter	8	pounds
Dried fruits	5	“
Potatoes	½	bushel

Some “trimmings” and luxuries may be added. Experienced campers do not agree on the proper amounts and kinds of provisions. But both quantities and kinds can be made to suit the tastes of the party and their facilities for packing the supplies.

Handy Things to Know.

An acre of land contains 160 square rods.

An acre of land contains 43,560 square feet.

A square acre measures 208-71/100 feet on each side.

There are 5,280 feet in a mile. A kilometer is 62/100 of a mile and a meter 39-37/100 inches.

The right bank of a stream is toward your right hand as you stand facing down stream.

WEIGHTS AND MEASURES.

Line Measure.

12 inches = 1 foot
3 feet = 1 yard
5 yards (16½ feet) = 1 rod
320 rods = 1 mile

Surface and Square Measure.

144 square inches = 1 square foot
9 square feet = 1 square yard
30¼ square yards = 1 square rod
160 square rods = 1 acre
640 acres = 1 square mile

Cubic or Solid Measure.

1728 cubic inches = 1 cubic foot
27 cubic feet = 1 cubic yard
16 cubic feet = 1 cord foot
8 cord feet } = 1 cord
128 cubic feet }

Liquid Measure.

4 gills = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

Dry Measure.

2 pints = 1 quart
8 quarts = 1 peck
4 pecks = 1 bushel

Avoirdupois Weights.

16 ounces = 1 pound
2000 pounds = 1 ton

Miscellaneous Tables.

12 units = 1 dozen
12 dozen = 1 gross

Paper Trade Measure.

24 sheets = 1 quire
20 quires = 1 ream

Surveyor's Measure.

7.92 inches = 1 link
25 links = 1 rod
4 rods = 1 chain

Muzzle Velocity of Rifle Bullets

Cartridge	Foot Secon
.22 Long Rifle, Rim Fire, Black Powder	1103
.22 Savage, High Power	2700
.25-20 Smokeless	1468
.30 U. S. Krag	2005
.30 Springfield, 1906	2700
.30-30 Smokeless	2020
.30 Remington Rimless	2020
.303 Savage Smokeless	1985
.32 Special Smokeless	2112
.32-40 Smokeless	1505
.32-40 High Power	2065
.38-55 Smokeless	1321
.38-55 High Power	1700
.38-40 Smokeless	1325
.38-72 Smokeless	1483
.401 Self Loading Rifle	2142
.40-65 Smokeless	1420
.40-70 Smokeless	1457
.405 Smokeless	2204
.44 Winchester, Smokeless	1301
.45-90 Smokeless	1660
.45-70 Smokeless	1361
7 M-M Mauser	2300
8 M-M Mauser & Mannlicher	2050

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